ARTICLE XI.

Observations made in the years 1838, '39, '40, '41, '42, *and* '43, *to determine the Magnetical Dip and the Intensity of Magnetical Force, in several parts of the United States. By John Locke, M.D., Professor of Chemistry and Pharmacy in the Medical College of Ohio. Read April* 19, 1844.

POPULAR EXPLANATION OF THE ELEMENTS OF TERRESTRIAL MAGNETISM.

In endeavouring to ascertain, by experiment, the elements of terrestrial magnetism, the operator proceeds, without reference to any theory, to determine them as the values of a *simple force* acting in a certain direction, regardless of what may be the nature or cause of that force. The nature of the research will be understood, by referring to the investigation of a similar force, namely, gravitation, which has likewise been examined as a simple force. The points of inquiry lie in the quantity of that force, and the direction in which it acts. By this investigation of gravitation, the following facts have been ascertained:

1. That gravitation is not uniform over all parts of the earth, but is less towards the equator than towards the poles.

2. That it is less in high than in low situations.

3. That it acts perpendicularly to the surface of the sea, and in general perpendicularly to the surface of the earth; but as the earth is not spherical, but spheroidal, and a section of it is an ellipse, gravitation does not tend towards the centre, except at the equator and at the poles; the point of convergence for regions near the equator being nearer than the centre, and for regions near the poles, farther than the centre.

4. That a mountain will, at a certain rate, in proportion to its mass and proximity, deflect the course of gravitation, and cause the lower end of a plumb line to lean towards it.

5. That the moon, sun, and planets, have an influence on the direction and force of gravitation, that influence depending on the mass, direction, and distance of the said bodies.

And, finally, there has been deduced the admirable Newtonian law: *That gravitation is a mutual force, acting, between all of the particles of matter in the universe, increasing directly as the quantity of matter, but diminishing, like other radiants, as the squares of*

the distance increase. This simple law, it is commonly known, lies at the foundation of the whole of physical astronomy, and is that law which renders it a perfect science.

The objects of the "magnetic crusade," as it has been called, have been:

1. To examine, as far as possible, all of the circumstances and conditions of this peculiar force, called magnetism, in all parts of the globe; and,
2. To endeavour to deduce, from the results, some law or laws which shall, like the above laws of gravitation, embrace all the phenomena, and, like that law, enable us to predict, not only the present condition of that force at any particular place, but its condition at any future time, and all of the intermediate revolutions which it may have undergone.

Magnetism, as a force, is identical with any other force, but it differs from gravitation in regarding, chiefly, one kind of matter only, and that matter in a peculiar condition, namely, ferruginous matter, possessing polarity.

The earth, all over its surface, and to the greatest heights and depths accessible to man, has the property of attracting a magnetized body, and of directing its polar axis in a particular course, and this property is called terrestrial magnetism. The elements of terrestrial magnetism, considered as a simple force, are only two; namely, the quantity or intensity of that force, and the direction in which it acts. But, in reference to other fixed lines and planes of position, we enumerate four elements of terrestrial magnetism. The planes to which these elements are referred are astronomical ones, the horizon and the meridian, and the line which they form by their intersection, the meridian line of any place. These four elements of magnetism are,

1. The variation or declination of the compass.
2. The horizontal intensity of force.
3. The dip or inclination.
4. The total intensity of force.

Of the Declination.—It is well known that the needle of the common compass does not, in all places, point to the true north, but makes an angle with the meridian greater or less, in one region, declining to the east, and, in another, to the west. This angle which the needle makes with the meridian line, is called the declination. A line on the chart accompanying this paper, called the "line of no variation," is traced from the lower end of Lake Superior, along the western shore of Lake Huron, across Lake Erie, and thence to the coast of North Carolina, passing through the places at which the needle will coincide with the meridian, and point to the true pole. In the parts of the United States to the eastward of this line, the declination or variation is westward, and, in parts to the westward of said line, it is eastward.

Of the Horizontal Intensity of Force.—The common compass needle is moved to the position which it finally occupies, by a certain force not in all places the same; which force, if it be drawn out of the line which it inclines to occupy, will bring it back again with a velocity proportionate to that force. This is called the horizontal intensity of force. It may be measured and compared by means of the number of vibrations which the same needle, deflected a few degrees from its course, will perform in a given time.

Of the Dip or Inclination.—The ordinary compass needle is so pivoted, above the centre of gravity, that it is compelled to move in the horizontal plane; but if it could move freely in a vertical plane, as a cannon can be elevated or depressed on its trunnions, it would not, in our latitude, remain horizontal, but the north end would descend, making an angle of about seventy degrees with the horizon. This angle, which a free needle would make with the horizon, is called the DIP or INCLINATION. At some point near the equator, the dip is nothing, and beyond that, to the south, the south end of the needle dips or descends below the level.

Of the Total Intensity of Force.—When a free needle has taken its position in the true line of the dip, it is held in that position by the *whole* force of the earth's magnetism; and this force, which may be determined by means of the dip and the horizontal force, is called the TOTAL INTENSITY OF FORCE.

Observations.—Now all these four quantities are found to vary, in passing, in certain directions, from one place to another, but there is usually some line along which each quantity is nearly the same. The lines, along which the variation is the same, are called lines of equal variation, as that from Lake Superior to North Carolina, along which the variation is nothing. Those lines along which the dip is equal, are called isoclinal lines, or lines of equal dip; as that on the chart, traced from the north-west corner of Illinois, through Indiana, the middle of Ohio, along the south part of Pennsylvania, through Philadelphia, to the Atlantic, marking the dip of 72°. Those lines, along which the total intensity is equal, are called isodynamic lines, or lines of equal force, as the several elliptical curves marked around Lake Superior, more or less parallel to each other. It will be seen that the development of these last lines has been the chief object of this paper.

A map of a country, with a delineation of these several lines, constitutes a magnetic chart of that country; a thing which cannot be made without much expense and labour, in the necessary experiments and calculations.

None of these quantities remain constant at the same place, but are undergoing a slow revolution; or, in other words, the several lines are gradually moving. Thus, the line of no variation, (and, with it, all lines of equal variation,) is gradually travelling westward. The city of Pittsburgh, Pennsylvania, which, a few years ago, had no variation, the line passing through it, has now a variation to the westward, the line of no variation being now found to the west of that city. The lines of equal dip have been said to be travelling slowly to the north, and the dip at any given locality to be, consequently, diminishing. Continued observations will determine this and other similar points.

Some Account of the Instruments, and of the Mode of Observation.

The following observations were made with instruments manufactured by the late Mr. Robinson of London. The dipping compass was furnished with two needles, each of six inches in length, and with the means of reversing their polarity. The results here tabulated, are, in each instance, the mean of sixteen readings, including all the usual

reversals. The hour of observing the dip is not put down in the tables, but it may in general be understood to have been about thirty minutes previous to the commencing of the observations for determining the intensity of force. The intensity apparatus was of the model invented by Professor Bache, by means of which Hanstenian needles are vibrated in a glass vessel nearly exhausted of air.

In almost every case these vibrations were commenced with an arc of about seven degrees on each side of the magnetical meridian, and continued to the number of five hundred, the arc then being between one and two degrees. The temperature was currently noted by means of an interior thermometer, and the duration of the vibrations reduced to the standard temperature of 60° Fahrenheit. The constant co-efficient for the effect of temperature on each needle, was determined by experiments in a room in the first place at the temperature of about 40°, and next in the same room artificially heated by a copper stove to near 90°. The result of these experiments was that the co-efficients for the several needles were as follows:

No. 1. .00012	No. 4. .000065
" 2. .000145	" 5. .000070
" 3. .000058	" 6. .000088

Needle No. 1, made by Robinson, was found to be somewhat inconstant in its magnetism, as will be seen by the observations recorded in the tables, some slight changes are also apparent by the results by No. 2, but Nos. 4, 5, and 6, made by myself, have proved themselves to be of superior quality. They were made of watch-makers' steel wire, and, were left at the highest degree of hardness which could be given to them by fire and water.

The chronometer used, made by Molyneux, was in all cases kept running so near to the mean rate that no equation was necessary except in the expedition to Lake Superior in 1843, when its daily rate was found to be fourteen seconds too fast. I regret that it was not always in my power to determine with more precision the magnetical declination, which I observed in but few instances, and then only by means of plumb-lines and naked sights, in the ordinary manner of the United States surveyors.

Explanation of the following Tables.—At the head of each is placed the date and the latitude and longitude of the place, either from the best observations, or from the most approved maps, Tanner's being, for the most part, preferred. In the Iowa and Wisconsin region, Judson's map was used, and, in the region of Lake Superior, Captain Bayfield's, as published by the Society for the Promotion of Useful Knowledge.

In the first column is placed the dip, as determined by the mean of sixteen observations; in the second, the number designating the intensity needle; in the third, the epoch of commencing the vibrations; in the fourth the observed duration of five hundred vibrations; in the fifth, the mean temperature, as indicated by an interior thermometer; in the sixth, the calculated duration at the standard temperature of 60°; in the seventh, the square of the number found in the sixth column; in the eighth, the horizontal intensity, that at Cincinnati, at some specified date, being reckoned 1000; in the ninth, the total intensity of force, in terms of the above named horizontal intensity at Cincinnati; in the tenth, the TOTAL INTENSITY OF FORCE, that at Cincinnati being recorded 1000. In the

course of these tables, rules are given by which these results may be reduced to the standard of unity adopted by Colonel Sabine, in his Report on Magnetism in 1838.

Correspondence.—After reducing my observations, in 1843, and putting them into the tabular form, I then compared them with the charts in Colonel Sabine's Report, above named, and was agreeably surprised at the coincidence of my actual observations with the chart lines which he had projected by means of surrounding observations, made so distant as the Atlantic, Baffin's Bay, and the Pacific. I immediately addressed letters to my friend Sears C. Walker, of Philadelphia, to the superintendent of the Magnetical Observatory, at Toronto, to the National Institute, at Washington, and to Colonel Sabine, R. A., at Woolwich, England, announcing briefly the result of my labours, and soliciting information as to what others had been accomplishing. Most of these letters were promptly responded to, and from Mr. Walker, Professor Bache, and Colonel Abert, I received valuable information, communicated in terms of great kindness. I have finally received a reply from Colonel Sabine, containing precisely the information which I desired, and encouraging me to further exertions in the same department of research, most obligingly offering me such assistance, in procuring instruments, as I might need. I quote, below, my own letter to the National Institute, as published by Colonel J. J. Abert, to whom it was addressed, and who, in conjunction with Mr. F. Markoe, communicated it to the National Intelligencer.

"*Medical College of Ohio, Cincinnati, October* 16, 1843.

"DEAR SIR:

"I ask the favour of you to announce to the National Institute, that, in my late tour to Lake Superior, I have discovered what is probably the place of maximum intensity of terrestrial magnetism. Major Sabine, in his Report to the British Association, in 1838, gives a chart of isodynamic lines in the northern hemisphere, on which he describes the line of intensity, 1.70, as an ellipsoid, extending, in latitude, from 35° to 69° north, and from Nova Scotia to the Pacific, almost, if not quite returning into itself at Behring's Straits; within this ellipsoid he has given a small portion of the line of 1.80, commencing at New York, and curving southward and westward to the Ohio River, and thence across the middle of Lake Erie. He suggests that this must be a closed curve, and adds, "as must also be that of 1.90, *supposing such to exist.*" This would suggest that, somewhere within this curve, there would be a point of maximum intensity, a kind of pole of greatest attraction, separate from the pole of greatest dip, and from that of the convergence of the magnetical meridians. Major Sabine observes, that "the intensities in Baffin's Bay and in the polar sea, have all a much lower value than at New York, and the general configuration of the line of intensity would rather point to a maximum in the vicinity of the shores of Hudson's Bay." These suggestions of Colonel Sabine are, in general, substantially supported by my observations, but the place of maximum intensity is much farther south than Hudson's Bay, being on Kewenan peninsula, on the south shore of Lake Superior. At this place, the intensity of one locality reached 1.97, and that of a mean of a group of observations, made in various neighbouring localities, was as high as 1.918. On the north side of the lake, at Isle Royal, it was found to be 1.908. I have just now completed the reduction of all my observations since 1838, and prepared them

for publication. They extend, geographically, from Cambridge, in Massachusetts, to Iowa territory, and from the middle of Kentucky to the north side of Lake Superior, including dip and intensity, and, in some places, declination also.

"Respectfully, Sir, your friend and obedient servant,

"JOHN LOCKE."

"To Colonel J. J. Abert."

A letter containing, substantially, the same information as the above, was, about the same time, addressed to Colonel Sabine, from whom, in due time, was received a prompt and obliging answer, from which the following is an extract.

"*Woolwich, (England,) November* 22, 1843.

"Dear Sir:

"I hasten to acknowledge the receipt of your very obliging and agreeable letter of the 25th of October. I am very glad to learn that the 'Report on Magnetism,' which I took the liberty of sending you in 1840, reached you in safety, and I cannot but be most highly gratified to hear that it in any degree contributed to induce you to undergo the labour and fatigue of making the series of magnetical observations over the extensive and important district of which you speak. I cannot doubt that so valuable a contribution to magnetical science, bearing so immediately on one of the critical points of magnetical theory, will be most warmly welcomed by one of your own national institutions, and will be published, as it is so desirable it should be, among the scientific records of the nation. Permit me to express the hope that, not less for the interests of science than for your own sake, you will spare no endeavour to obtain a very early publication of your observations. Both what they accomplish and what they leave unaccomplished will be a guide to those engaged in similar undertakings. The magnetic survey which is now in progress, under the direction of Lieutenant Lefroy, in British North America, is making a very rapid and successful advance, and promises to furnish ample materials for maps of the three magnetical elements north of the United States frontier. It is much to be desired that the survey should be met at the frontier by researches of citizens of the United States, conducted on their own grounds. I learn from your letter that you have yourself achieved already a very considerable part of this undertaking. The field of operation is thus greatly narrowed on the one hand, while, on the other, a full knowledge of the results which are obtained may be expected to indicate the direction in which further researches can be most profitably made. Lieutenant Lefroy informs me that in his journey from Toronto to York factory, on Hudson's Bay, pursued by the usual route of the Hudson's Bay Company boats, he found the magnetic force to increase until he arrived in the neighbourhood of Rainy Lake; at which spot it began to decrease, and continued to do so all the way to York factory. His observations would therefore seem to correspond in a remarkable degree with yours, in the indication of the locality of the maximum of intensity of the force; and we may infer that the principal axis of the inner isodynamic ovals crosses the meridians of 88° to 94° west, in the parallels of 47° to 48° north. For a more exact determination an examination on a north and south line, ascending the Mississippi to the point from whence the country can be most conveniently crossed

to the Red River, with the descent of the Red River to Lake Winnipeg,—and a transverse or east and west line, through the spot, or not very distant from it, where the highest intensity should be found in the north and south line, would appear extremely desirable; the east and west line to be pursued in both directions until the intensity of the force should be decidedly decreasing.

"Believe me, my dear Sir, with much respect, very sincerely yours,

"EDWARD SABINE."

I. SERIES, 1838, OHIO.

Cincinnati, Latitude 39° 06′; Longitude 84° 22′, W.; March 20, 1838.

Dip.	No. of Needle.	Epoch of commencing Vibrations.	Duration of 500 Vibrations	Temperature.	Calculated duration at 60°	Square of the preceding.	Horizontal intensity.	Total intensity, Hor. being 1000.	Total intensity, that at Cincinnati being 1000.
70°28′08″	1	2*h*.03*m*.05*s*.6 P	1544.00	89°00	1538.63	2367382.2769	1000		
	2				1513.76	2291469.3376	1000		
	3				1235.60	1525225.0000	1000		
						Mean,	1000	2991.1	1000.

Remarks.—Needle No. 1. The mean time or duration for five hundred vibrations at the temperature of 60° deduced from ten series, of five hundred vibrations each, made March 10, is equal to 1540.20.

Needle No. 2. The mean time or duration of five hundred vibrations, at the temperature of 60°, deduced from five series, of five hundred vibrations each, made March 10 to 11, is equal to 1513.76.

Needle No. 3. The duration of five hundred vibrations at the temperature of 60°, deduced from ten series, of five hundred vibrations each, made January 17 to 20, equal to 1235.60.

Locality. Longworth's garden. Substratum, diluvial loam and gravel based on the horizontally stratified blue limestone of the silurian formation.

Dayton, Latitude 39° 44′, N.; Longitude 84° 17′, W.; March 26, 1838.

1°22′42″	1	3*h*.00*m*.00*s*.6 P	1572.80	73°00	1570.35				
	1	2 55 04 0*	1578.	85 30	1573.27				
				Mean,	1571.81	2470555.24	958.25		
	2	6 30 04 5 A	1544.40	53 00	1546.00				
	2	8 24 01 6	1548.00	60 75	1548.00				
				Mean,	1547.00	2393209.00	957.20		
	3	7 14 04 4	1260.00	55 6	1260.32				
	3	9 13 01 2	1262.00	67 5	1261.45				
				Mean,	1260.88	1589868.81	959.20		
		* March 27.				Mean,	958.20	3001.0	1003.2

Geology. Alluvium underlaid by horizontally stratified blue limestone.

Springfield, Ohio, Latitude 39° 54′; Longitude 83° 51′; March 29, 1838.

71°27′23″	1	9*h*.58*m*.02*s*.4 A	1580.00	67°50	1578.58	2491914.8164	950.02		
	2	11 17 05 2	1557.80	71 00	1554.72	2417154.2784	948.00		
	3	12 33 02 0	1268.00	72 00	1267.72	1607113.9984	949.04		
						Mean,	949.02	2984.3	997.8

Substratum, cliff limestone in horizontal strata. Place, ½ mile north of the village.

Urbana, Ohio, Latitude 40° 05′; Longitude, 83° 48′; March 3, 1838.

Dip.	No. of Needle	Epoch of commencing Vibrations.	Duration of 500 Vibrations.	Tempe-rature.	Calculated duration at 60°	Square of the Preceding.	Horizontal intensity.	Total intensity, Hor. being 1000	Total intensity, that at Cincinnati being 1000.
71°39′45″	1	4*h*.34*m*.02*s*. P	1577.6	63°5	1577.00	2486929.00	951.93		
	2	5 18 02 0	1552.8	60 0	1552.80	2411187.84	954.53		
March 31,	3	10 21 04 6 A	1265.4	70 0	1264.87	1599896.12	953.32		
						Mean,	953.26	3027.9	1012.2

Cliff limestone deeply covered with diluvial gravel.

Columbus, Ohio, Latitude 39° 57′, N.; Longitude 83° 02′, W.; April 2, 1838.

71°04′52″	1	11*h*.00*m*.05*s*.6 A	1559.6	49°	1561.60	2438594.56	966.69		
	2	11 41 00 8	1538.8	50	1541.00	2374681.00	964.95		
	3	12 39 04 4	1254.0	51	1254.65	1574146.6225	968.28		
						Mean,	966.64	2981.3	996.72

Geology, cliff limestone.

II. SERIES, 1839, IOWA, WISCONSIN, &c.

2. St. Louis, Latitude 38° 36′, N.; Longitude 90° 15′, W.; September 6, 1839.

69°31′26″	1	1*h*.02*m*.00*s*. P	1514.4	84°5	1509.95	2279949.0025	1038.40		
	2	1 42 00	1490.4	87 5	1484.46	2203621.4916	1048.18		
	3	2 18 04 4	1211.9	87 0	1210.00	1464100.	1042.32		
						Mean,	1042.97*	2981.50	997.35†

Locality. Mrs. Asherly's garden, near the reservoir, and the ancient mound-works.
Geology. Horizontal carboniferous limestone.

3. Davenport, Iowa, Latitude 41° 30′, N.; Longitude 90° 34′, W.; September 13, 1839.

71° 55′	1	3*h*.01*m*.01*s*.2 P	1591.6	70°5	1588.74	2524094.7876	937.98		
	2	4 00 59 2	1568.8	69 5	1566.64	2454360 8896	941.91		
	3	4 49 02 8	1274.8	67	1274.28	1623789.5184	939.82		
						Mean,	939.90	3028.03	1012.91

Declination 7° 50′, east, (surveyors.) Locality,—at the foot of the hill north of town; carboniferous limestone.

4. Davenport again, on the hills north of Shoemaker's Spring; Latitude 41° 30′; Longitude 90° 36′.

71°55′15′	1	3*h*.03*m*.03*s*.2 P	1593.6	76°	1590.3	2529044.90	936.12		
	2	3 43 04 4	1571.6	75	1568.2	2459251.24	939.32		
	3	4 43 59 6	1276.4	75	1275.3	1626390.09	938.32		
						Mean,	937.92	3021.32	1011.00

5. Lost Grove, (Iowa,) Latitude 41° 39′, N.; Longitude 90° 25′, W.; September 23, 1839.

72°02′26″	3	2*h*.45*m*.03*s*.6	1278.	75°	1276.9	1630473.61	935.96	3028.46	1015.39

Locality and geology. Near the point where the cliff limestone, coming up, with a gradual dip from the south, emerges from underneath the carboniferous limestone, to occupy the surface northwardly, nearly to Prairie du Chien.

* Horizontal intensity at Cincinnati, August 18, 1840, being 1000.

† Total intensity at Cincinnati, August 18, 1840, being 1000.

6. Wapsipinnicon River, (Iowa,) Latitude 41° 44′, N.; Longitude, 90° 39′, W.; September 25, 1839.

Dip.	No. of Needle.	Epoch of commencing Vibrations.	Duration of 500 Vibrations.	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal intensity.	Total intensity, Hor. being 1000.	Total intensity, that at Cincinnati being 1000.
72° 15′	1	9h.04m.59s.6	1596.	56°	1596.77	2549674.4329	928.54		
	2	9 59 00 4	1574.4	56 5	1575.02	2481255.0400	930.89		
	3	11 12 03 2	1280.4	61 7	1280.27	1639091.2729	931.04		
						Mean,	930.16	3051.06	1020.61

Declination, 8° 25′, east. Observed by myself.

Locality: on the rocky table or upper bank of the river, which was in a channel moderately deep. Geology: cliff limestone cropping out at bluff banks, but covered generally with good soil, prairie and scattered timber. Wind from north-west, blowing by gusts, a moderate gale; clouds ragged cumulo-stratus, covering half of the sky, each occupying 10 to 30 degrees. Sky beautifully blue and clear between.

7. Iron ore bed, (Iowa,) Latitude 41° 55′, N.; Longitude 90° 56′, W.; September 27, 1839.

72°50′30″	3	8h.51m.03s.2 A	1295.2	49°	2960.4	1679719.6816	908.52	3079.59	1030.16

Declination, 7° 05′, east, (Locke.)

Locality, about three quarters of a mile from the Wapsipinnicon river. Surface rather uneven. The iron ore in place appeared to be the hydrated peroxide, often hematitic, not at all magnetic, but some loose pieces, probably transported, were not only magnetic, but actually possessed polarity. The magnetism of this place, it appears, is peculiar, the dip and intensity being both greater than the latitude elsewhere exhibits.

8. Mill at Brown's Settlement, Latitude 42° 02′, N.; Longitude 91° 18′, W.; September 30, 1839.

72° 21′	1	11h.10m.04s.0 A	1603.6	53°	1605.	2576025.	919.05		
	2	11 54 00 4 A	1586.0	55 5	1587.03	2518664.2209	917.07		
	3	12 40 02 0 P	1289.0	57 6	1289.18	1661985.0724	918.22		
						Mean,	918.11	3028.05	1012.92

Declination, 9° 10′, east, (surveyors;) 9° 04′, by my own observation. Locality, in a valley.

9. Branch of the Makoqueta River, Latitude 42° 14′, N.; Longitude 91° 09′, W.; October 2, 1839.

72°43′37″	3	9h.40m.02s.0 A	1300.	64°	1299.7	1689220.09	903.41	3042.57	1017.77

Declination, 8° 45′, east, (by surveyors.)

Locality, near a bluff or cliff limestone thirty feet high. Weather clear and fine; a few cirrus clouds.

10. Farmers' Creek, (Iowa,) Latitude 42° 13′, N.; Longitude 90° 39′, W.; October 5, 1839.

72° 36′	1	12h.43m.01s.2 P	1613.2	76°	1610.1	2592422.01	913.24		
	2	1 21 01 6 P	1594.	83 28	1588.7	2522867.69	915.54		
	3	3 52 00 8 P	1292.4	66	1291.95	1669134.8025	914.29		
						Mean,	914.36	3057.64	1022.82

Declination, 9° 11′, east, by my own observation, and 9° 4′, by United States surveyors. High tables of cliff limestone cut deeply, and abruptly, by the streams, characterize

this neighbourhood. The experiments were made on the margin of the creek, under the shadow of a shelving rock, which, being about nine feet high, served to screen the apparatus from the sun. The table land undulating, fertile, grassy prairie.

11. White Water, (Iowa,) Latitude 42° 18′, N.; Longitude 90° 51′, W.; October 18, 1839.

Dip.	No. of Needle.	Epoch of commencing Vibrations.	Duration of 500 Vibrations.	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal intensity.	Total intensity, Hor. being 1000.	Total intensity, that at Cincinnati being 1000.
72° 55′	3	11*h*.04*m*.00*s*.4	1308.8	77°5	1307.47	1709477.8009	892.70	3038.85	1016.53

Declination, 9° 10′, east, (surveyors.)
Locality, in the sandy channel of a dried up brook, beside a limestone bluff.

12. North Branch of Makoqueta, Latitude 42° 23′, N.; Longitude 91° 09′, W.; October 9, 1839.

72° 51′	3	11*h*.59*m*.59*s*.6 A	13096.	59°	1309.67	1715235.5089	889.71	3017.25	1009.31

Declination, 9° 35′, east, (surveyors.)
Cloudy and interruptedly rainy, with gusts of wind from the south. Observations made inside of the tent. Dipping needle fluctuating, as if by an aurora or a "magnetical storm."

13. Dubuque, (Iowa,) Latitude 42° 29′, N.; Longitude 90° 39′, W.; October 14, 1839.

73° 05′	3	12*h*.51*m*.03*s*.6 P	1316.	54°	1316.46	1733066.9316	880.55	3028.66	1013.00

Declination, 8° 22′, east, (surveyors.)
At Dubuque's grave, one mile distant from this locality, the dip is 73° 05′ 45″. The dip and intensity, as first given, were taken in the bottom of Dougherty's Lead mine, one hundred feet deep; both the dip and intensity appeared to be the same as at Dubuque's grave, a locality about a mile distant, and immediately on the river bank. The lead mine is a vertical fissure in the limestone, from three to twelve feet wide, running from east to west, and but partially worked out. It would not seem, then, that these veins of Galena exert any sensible influence on the magnetic elements.

14. Forks of Little Makoqueta, (Iowa,) Latitude 42° 31′, N.; Longitude 90° 47′, W.; October 20, 1839.

73° 08′	1	6*h*.15*m*.04*s*. A	1634.	34°	1639.4	2687632.36	880.88		
	2	7 02 04 4	1612.	36	1616.16	2611973.1456	884.31		
	3	8 16 00 4	1317.	51 3	1317.86	1736754.9796	878.61		
						Mean,	881.27	3037.34	1016.02

Declination, 8° 30′, east, (surveyors.)
Clear, brisk north wind. Experiments made inside of the tent, all iron being removed. Locality, the diluvial bottom of a small stream, having perpendicular bluffs of horizontal cliff limestone, two hundred feet high, on each side, and distant, say four hundred yards.

15. Turkey River, (Iowa,) Latitude 42° 42′, N.; Longitude 91° 05′, W.; October 22, 1839.

73° 11′	3	10*h*.11*m*.04*s*.8	1322.4	65°	1322.	1747684.	873.19	3018.18	1009.61

Declination, 9° 00′, east, (surveyors.)

Locality, on the alluvion of the river, near a town called Winchester. High cliff limestone bluffs at a moderate distance from the valley of the stream. Cloudy, smoky, calm. Barometer 749.4 mill.; thermometer 16. cent.

16. Prairie du Chien, W. T., Latitude 43° 01′, N.; Longitude 91° 08′, W.; October 24, 1839.

Dip.	No. of Needle.	Epoch of commencing Vibrations.	Duration of 500 Vibrations.	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal intensity.	Total intensity, Hor. being 1000.	Total intensity, that at Cincinnati being 1000.
73°16′35″	3	11*h*.28*m*.02*s*.4	1320.	65°	1319.62	1741396.9444	876.34	3045.44	1018.73

Declination, 9° 5′, east, (surveyors.)

Although noted at Prairie du Chien, the experiments were made at the ferry, on the side of the Mississippi opposite the prairie, on a low alluvion, surrounded very closely by precipitous bluffs of sandstone and limestone, geologically lower than the cliff, and scarcely fossiliferous, but still horizontally stratified.

17. Blue Mound, W. T., Latitude 43° 01′, N.; Longitude 89° 54′, W.; October 29, 1839.

73° 41′	3	1*h*.55*m*.03*s*.2 P	1335.6	46°	1336.7	1786766.89	854.00	3038.54	1017.43

Declination, 8° 38′, east, (surveyors.)

The above locality is in the bed of a streamlet west of the West Mound. The Blue Mounds are conical outliers of the cliff limestone, three hundred feet of their upper part being silicious chest, horizontally stratified. The base contains lead ore. They rest on sandstone, and are one thousand feet above the Wisconsin river.

18. Madison, W. T., Latitude 43° 05′, N.; Longitude 89° 41′, W.; November 2, 1839.

74°03′30″	1	10*h*.20*m*.00*s*.4	1666.8	54° 1	1667.2	2779555.84	851.79		
	2	9 15 03 2	1643.2	45	1647.17	2713169.0089	851.32		
	3	8 39 00 0	1336.4	44 5	1337.5	1788906.25	852.06		
						Mean,	851.72	3102.25	1037.76

Declination, 7° 30′, east, (surveyors.)

Locality, near the capitol, say four hundred yards from it. The rocks are limestone, horizontally stratified, but scarcely fossiliferous. No height around much above the site of the observations.

19. Mineral Point, W. T., Latitude 42° 50′, N.; Longitude 90° 10′, W.; November 5, 1839.

73°20′37″	1	12*h*.07*m*.03*s*.2	1646.8	43°	1650.15	2722995.0225	869.45		
	2	12 46 01 6	1627.6	44	1631.37	2661368.0769	867.89		
	3	11 36 00 4	1324.4	44	1325.63	1757294.8969	868.47		
						Mean,	868.60	3030.40	1013.70

Declination, 8° 40′, east, (surveyors.)

Locality, a moderately deep valley, one mile east of town, with no bluffs or peculiar elevation near. Geology, cliff limestone, horizontally stratified, and containing lead ore, and some copper in the underlying rock.

At 6*h*. A.M. Barometer 720.0 millimeters; thermometer 6. cent. Wind north.

20. Cincinnati, Latitude 39° 06′, N.; Longitude, 84° 22′, W.; September 24, 1840.

Dip.	No. of Needle	Epoch of commencing Vibrations.	Duration of 500 Vibrations.	Temperature.	Calculated duration at 60°.	Square of the Preceding.	Horizontal intensity.	Total intensity, Hor. being 1000.	Total intensity, that at Cincinnati being 1000.
70°29′11″	1	11*h*.19*m*.00*s*.6	1542.8	66°4	1541.6	2377147.24	995.94		
	2	12 00 03 8	1524.6	70	1522.4	2317701.76	996.58		
	3	12 39 01 2	1237.2	70	1236.48	1528932.25	998.12		
						Mean,	996.88	2984.40	998.31

III. SERIES, 1840, OHIO, KENTUCKY, AND INDIANA.

21. Cincinnati, August 18, 1840, Latitude 39° 06′, N.; Longitude 84° 22′, W.

70°27′26″	1	11*h*.09*m*.01*s*.2 A	1542.	78°	1538.67	2367505.3689			
	2	12 13 01 6 P	1524.	78 75	1519.8	2309792.04			
	3	1 06 01 6	1235.34	78 5	1235.34	1526064.9156			
						Mean,	1000	2989.4	1000.

Done at the most usual locality for Cincinnati—Mr. Longworth's garden, under the bank descending towards Deer Creek. Coefficients for the several needles as follows, namely, No. 1, 00012.; No. 2, 000145.; No. 3, 000058.

22. Hamilton, Ohio, Latitude 39° 23′, N.; Longitude 84° 32′, W.; August 20, 1840.

70° 58′	1	10*h*.42*m*.02*s*. A	1560.8	80°	1557.05	2424404.70	976.55		
	2	11 18 03 6	1540.4	85	1535.0	2356225.	980.24		
	3	11 57 01 4	1250.6	82	1249.0	1560001.	978.02		
						Mean,	978.33	2999.9	1003.50

23. Dayton, Ohio, Latitude 39° 44′, N.; Longitude 84° 17′, W.; August 21, 1840.

71° 22′	1	2*h*.14*m*.00*s*.0 P	1578.8	83°5	1574.34	2478546.4356	9511.		
	2	2 53 02 2	1561.4	84 0	1555.77	2420420.2929	9543.		
	3	3 27 00 0	1264.	84 0	1262.24	1593249.8176	9577.		
						Mean,	9544.0	298.71	999.15

Locality, the broad alluvion of Dayton, underlaid with gravel. Rocks in situ, the blue horizontal limestone, the same as at Cincinnati. Meteorology, clear with a mixture of cirri and cumuli. Some distant thunder, but no rain. Wind south-east, gentle. Evening clear, with some meteors.

24. Piqua, Ohio, Latitude 40° 06′, N.; Longitude 84° 13′ 5″, W.; August 22, 1840.

71°35′50″	1	4*h*.41*m*.00*s*.8 P	1585.2	80°	1581.4	2500825.96	946.60		
	2	5 26 59 6	1568.0	79	1563.7	2445157.69	944.60		
	3	6 06 00 0	1270.0	70	1269.26	1602094.76	947.20		
						Mean,	946.10	2997.3	1002.60

Geology, horizontal cliff limestone, country level.

25. Lebanon, Ohio, Latitude 39° 26′, N.; Longitude 84° 06′, W.; August 24, 1840.

71°02′45″	1	4*h*.53*m*.00*s*.4 P	1563.2	77°5	1560.	2433600.	972.84		
	2	5 34 00 8	1545.6	75 5	1542.13	2378164.9369	971.25		
						Mean,	972.04	2993.63	1001.07

Horizontally stratified blue limestone, near the surface.

26. Mason, Ohio, Latitude 39° 22′, N.; Longitude, 84° 13′, W.; August 25, 1840.

Dip.	No. of Needle.	Epoch of commencing Vibrations.	Duration of 500 Vibrations.	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal intensity.	Total intensity, Hor. being 1000.	Total intensity, that at Cincinnati being 1000.
70°54′12″	1	9h.30m.00s. A	1557.6	75°	1554.8	2417403.04	979.35		
	2	10 11 02 8	1543.2	77	1539.4	2369752.36	974.69		
	3	10 51 04 4	1251.2	78	1249.9	1562250.01	976.83		
						Mean,	976.90	2986.16	998.90

Calm, cloudless, fine. Locality, in the woods, on the level surface of the blue limestone.

27. Cincinnati, August 26, 1840.

70°27′54″	1	11h.4 m.59s.6 A	1542.8	74°4	1540.14	2372011.2196	998.10		
	2	11 40 04 8	1526.8	75 5	1523.37	2320656.1569	995.32		
	3	12 16 01 2	1238.0	76 5	1236.82	1529723.7124	997.67		
						Mean,	997.03	2981.74	997.43

Calm, sun shining, but through a hazy cloud.

It appears above, that although the total intensity at Mason, August 25, was less than the same at Cincinnati, August 18, yet it was greater than at the same place on the 26th. As this experiment was made on the day *succeeding* that at Mason, it may be taken as the nearest correct comparison.

28. Williamstown, Kentucky, Latitude 38° 36′, N.; Longitude 84° 22′, W.; September 1, 1840.

70°04′07″	1	10h.32m.59s.2 A	1532.4	77°	1529.27	2338666.7329	1012.3		
	2	11 23 13 2	1514.8	77	1511.07	2283332.5449	1011.1		
	3	12 06 01 4 P	1228.6	79	1227.25	1506142.5625	1013.2		
						Mean,	1012.2	2969.27	993.25

Locality, about half a mile east of Williamstown, on a ridge bordering a ravine. Rocks, blue fossiliferous limestone, underlying the soil. The greatest eastern elongation of polaris had for its azimuth 2° 57′, west of magnetic north. The variation or declination was then about 4° 57′, east. This was ascertained by the usual method adopted by surveyors, by means of plumb lines.

29. Lexington, Kentucky, Latitude 38° 06′, N.; Longitude 84° 18′, W.; September 2, 1840.

69°54′30″	1	4h.17m.10s.4 P	1531.2	74°	1528.63	2336709.6769	1013.22		
	2	4 54 02 4	1514.4	73	1511.56	2284813.6336	1010.93		
	3	5 30 00	1228.8	71	1228.09	1508205.0481	1011.84		
						Mean,	1012.00	2945.94	985.42

Weather cloudy. Locality, Richard Higgins's garden. Substratum, horizontal limestone, covered by a soil about nine feet deep. This is probably identical with the limestone of Cincinnati, but is more massive, containing less clay marl, which abounds at Cincinnati, interstratified with the thin layers of stone.

30. Clay's Ferry, Latitude 37° 54′, N.; Longitude 84° 18′, W.; September 3, 1840.

69° 49′	1	12h.20m.05s.2 P	1526.	75° 5	1523.25	2320290.5625	1020.35	2957.32	989.27

On the bank of the Kentucky river. Substratum limestone, the same as at Lexington A bluff limestone bank within one-third of a mile.

31. Frankfort, Kentucky, Latitude 38° 14′, N.; Longitude, 84° 40′, W.; September 4, 1840.

Dip.	No. of Needle.	Epoch of commencing Vibrations.	Duration of 500 Vibrations.	Temperature.	Calculated duration at 60°.	Square of the Preceding.	Horizontal intensity.	Total intensity, Hor. being 1000.	Total intensity, that at Cincinnati being 1000.
69°54′53″	1	11*h*.56*m*.00*s*.8 A	1528.8	73°5	1526.23	2329378.0129	1016.36		
	2	12 30 58 8 P	1511.6	73 0	1508.75	2276326.5625	1014.70		
	3	1 05 00 6	1227.6	72 5	1226.71	1504817.0741	1014.12		
						Mean,	1015.06	2954.76	988.76

Wind from the north; somewhat cloudy. Locality, half a mile east of the capitol, and on the south side of a ravine or ancient river bed, close to a precipitous limestone bluff.

32. Louisville, Kentucky, Latitude 38° 03′, N.; Longitude 85° 30′, W.; March 11, 1840.

69°54′26″	1	11*h*.40*m*.02*s*.4 A	1518.	39°5	1521.73	2315662.1929	1022.38		
	2	12 14 04 0 P	1498.4	41	1502.52	2257566.3504	1023.13		
	3	12 48 03 2	1219.2	43	1220.4	1489376.16	1024.63		
						Mean,	1023.38	2978.90	996.48

The close coincidence of horizontal intensities, at temperatures so different, is good evidence that the coefficients for temperatures have been correctly deduced. Locality, Jacobs' woods, a mile or more south-east of the court house; surface, level substratum cliff limestone. At Corn Island, in the falls of the Ohio, not two miles distant, the dip, by observations, September 7, 1840, was eight minutes more than at this locality. The same thing appeared in 1839.

33. Vernon, Indiana, Latitude 37° 59′, N.; Longitude 87° 47′, W.; September 10, 1840.

68°56′17″	1	11*h*.30*m*.02*s*.4 A	1493.2	75°5	1490.42	2221351.7764	1065.79		
	2	12 14 02 8 P	1477.2	76	1473.77	2171998.0129	1063.44		
						Mean,	1064.61	2964.51	991.33

Clear, wind gentle. Locality, a dense wood on the "bottom land," or river alluvium, five hundred yards east of the town-landing. Substratum, the horizontal sandstone of the coal formation.

34. New Harmony, Indiana, Latitude 38° 11′, N.; Longitude 87° 48′, W.; September 11, 1840.

69°03′37″	1	3*h*.00*m*.02*s*.0 P	1496.8	70°	1495.00	2235025.	1059.27		
	2	3 35 01 2	1480.0	69 5	1478.85	2186997.3225	1056.15		
	3	4 10 03 6	1201.2	70 0	1200.50	1441200.25	1058.88		
						Mean,	1058.10	2961.80	990.76

Cloudy. Locality, on the bank of the Wabash river, at what is called the "cut off," three-fourths of a mile south-west of the town. Substratum, sandstone of the coal measure.

35. Princeton, Indiana, Latitude 38° 23′, N.; Longitude 87° 30′, W.; September 16, 1840.

69°22′48″	1	9*h*.45*m*.59*s*.2 A	1507.6	75°5	1504.8	2264423.04	1045.52		
	2	10 20 01 6	1491.2	78 0	1487.3	2212061.29	1044.18		
	3	11 11 00 0	1209.6	79 25	1208.25	1459868.0625	1045.34		
						Mean,	1044.68	2966.40	992.29

Locality, one-third of a mile north of the court house, in a thick wood of small timber, soil, clay and level, evidently wet in the spring season. Geology, horizontal sandstone of the coal measures. Wind southwardly, signs of approaching rain.

36. Vincennes, Indiana, Latitude 38° 43′, N.; Longitude 87° 25′, W.; September 18, 1840.

Dip.	No. of Needle.	Epoch of commencing Vibrations.	Duration of 500 Vibrations.	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal intensity.	Total intensity, Hor. being 1000.	Total intensity, that at Cincinnati being 1000.
69°51′10″	1	10*h*.12*m*.02*s*.4 A	1517.6	58°5	1517.86	2303929.3369	1027.56		
	2	11 06 03 6	1502.0	60 5	1501.9	2255703.61	1024.25		
	3	11 46 04	1219.6	62 5	1219.42	1486985.1364	1026.28		
						Mean,	1026.03	2978.89	998.54

Clear, calm, wind westward. Locality, bank of the Wabash river, one and one-fourth miles above Vincennes. Soil, alluvial substratum sandstone, of the Illinois coal basin.

37. Paoli, Indiana, Latitude 38° 35′, N.; Longitude 86° 25′, W.; September 20, 1840.

69°33′47″	1	10*h*.05*m*.00*s*.4 A	1517.2	71°	1515.2	2295831.04	1031.22		
	2	10 44 00	1499.6	73	1496.77	2240320.4329	1031.01		
	3	11 31 58 4	1216,4	76	1215.27	1476881.1729	1033.30		
						Mean,	1031.84	2953.68	988.04

One-fourth of a mile north-east of the court house, on a side hill. Substratum, compact horizontal limestone, (the carboniferous.) Clear, calm, very fine; wind north-west.

38, Cincinnati, September 24, 1840.

70°29′11″	1	11*h*.19*m*.00*s*.6 A	1542.8	66°4	1541.8	2377147.24	995.94		
	2	12 00 03 8 P	1524.6	70	1522.4	2317701.76	996.58		
	3	12 39 01 2	1237.2	70	1236.5	1528932.25	998.12		
						Mean,	996.88	2984.40	998.31

Latitude and locality as before described.

IV. SERIES, 1841, CINCINNATI TO NEW YORK.

39. Total intensity at Cincinnati, May 8, 1841, compared with that at the same place, August 18, 1841, the last being reckoned unity.

70°26′11″	1	11*h*.44*m*.00*s*.4	1539.6	59° 17	1539.62	2370368.16			
	2	12 17 00 4	1520.	61 4	1519.69	2309457.6961	1000.01		
	3	12 47 03 6	1236.	62	1235.86	1527349.9396	999.16		
	4	1 12 02 8	1110.4	62	1110.26	1232677.2676			
	5	1 36 00 8	1350.8	63	1350.52	1823904.2704			
	6	2 03 01 2	1347.2	63	1346.84	1813977.9866			
	Mean of the horizontal intensity by the needles Nos. 2 and 3,						999.58	2983,88	998,56

After obtaining the horizontal intensities, as above, by dividing the squares of the duration of five hundred vibrations at any place into similar squares at the place assumed as the standard of unity, the reductions for total intensity were effected by the following formulæ, always using Hassler's logarithmic and trigonometric tables, as published in New York, in 1830.

As cos. 70°26′11″		9.5248544,	Magnetic dip at Cincinnati, May 8, 1841.
Is to R.		10.	Logarithmic radius.
So is	9.9956	0.9998176	Hor. Int. at Cincinnati, May 8, that at the same place Aug. 18, 1840, being 10.
To	29.8513	1.4749632*	Total intensity, May 8, horizontal intensity, August 18, 1840, being 10.

* 1.4751456, Log. of total intensity, horizontal being unity.

And as	29 8940	1.4755891	Total intensity, August 18, 1840, horizontal being 10.
To	29.8513	1.4749632	Total intensity, May 8, &c.
So is	10.	1.	Horizontal intensity at Cincinnati, August 18, 1840, assumed as unity.
To	99.856	0.9993741	Total intensity, May 8, that on August 18, 1840, being 10.

Thus it appears that the magnetical intensity at Cincinnati, May 8th, 1841, was extremely near that at the same place in August 18, 1840, which has been used as the unit or standard of comparison for the Iowa and Wiskonsin observations, made in 1839, the difference being only 1.44 parts in 1000. It appears, by applying the equation $C = \frac{RH}{T}$, in which C = cosine of dip, R = radius, H = horizontal, and T = total intensity, that an increase of 1′45″ of the estimated dip would complete the equality.

If it be asked why I have not included more than two needles in obtaining the above mean result of the horizontal intensity, I answer, that No. 1, since being used, August 18, 1840, had been connected, by iron keepers, with No. 2, and had evidently changed its magnetism. Nos. 4, 5, and 6, had not been used in August, and, indeed, were for the first time used in this series.

Having made and explained the above comparisons, I shall proceed to use the squares of the times of five hundred vibrations of each of the six needles, as given above, for May 8th, 1841, as quotients or standards of comparison, for obtaining the values of intensities, as observed at other times and places referred to in the above, as unity. I had intended to have used the results obtained at Philadelphia as the standard of unity; but I have found it more convenient to refer all my observations to a locality to which I could have more frequent access, and at which I could, from time to time, observe the secular changes and anomalous fluctuations of the magnetical elements. I am rather surprised to find the total intensity at Cincinnati not only near to that at Philadelphia, but a little above it.

40. Total intensity at Cincinnati, May 8, 1841, horizontal intensity, at the same time and place, being 1, 10, or 1000.

As cos.	70° 26′ 11″	9.5248544	
To R.		10.	
So is	10	1.	Assumed horizontal intensity at Cincinnati.
To	29.8638	1.4751456	Total intensity at Cincinnati, May 8, 1841.

41. Philadelphia, Latitude 39° 57′, N.; Longitude 75° 10′, W.; March 30, 1841.

Dip.	No of Needle.	Epoch of commencing Vibrations.	Duration of 500 Vibrations.	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal intensity.	Total intensity, Hor. being 1000.	Total intensity, that at Cincinnati being 1000.
72°00′10″	1	1h.29m.01s.2	1604.	43°	1607.27	2583316.8529	917.57		
	2	2 06 01 2	1582.	44 2	1585.62	2514190.7844	918.57		
	3	2 40 03 6	1290.4	50	1291.15	1667068.3225	916.19		
	4	4 04 02 4	1156.8	44 5	1157.99	1340940.8401	919.26		
	5	4 33 00	1408.8	44	1409.98	1988043.6104	917.43		
	6	5 08 04 8	1403.6	43	1405.7	1975992.49	918.01		
						Mean.	917.84	2970.80	994.783

Particular locality, in the yard of the Magnetical Observatory, near the Girard College. Geology, probably primitive rocks, covered by many feet of gravel and drifted materials.

42. Philadelphia, March 31, 1841.

Dip.	No. of Needle.	Epoch of commencing Vibrations.	Duration of 500 Vibrations.	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal intensity.	Total intensity, Hor. being 1000.	Total intensity, that at Cincinnati being 1000.
72°01′20″	1	12*h*.32*m*.00*s*.8	1605.6	51°	1607.34	2583541.8756	917.11		
	2	1 22 04 4	1585.2	50 5	1587.38	2519775.1644	916.53		
	3	1 57 00	1290.5	51	1291.17	1667119.9689	916.12		
	4	2 52 02 8	1158.	51 5	1158.75	1342001.5625	918.53		
	5	3 22 59 6	1410.	50	1410.84	1990469.5056	916.53		
	6	3 55 02 8	1404.8	51 5	1405.85	1976414.2225	917.86		
						Mean,	917.11	2971.38	994.975

One hundred and fifty feet north-east of the Magnetical Observatory. Locality, same as before.

43. Pittsburgh, Pa., Latitude 40° 32′, N.; Longitude 80° 02′, W.; March 22, 1841.

72°43′30″	1	11*h*.00*m*.02*s*.8	1632.2	68°	1630.63	2658954.1969	891.47	3002.00	1005.23

Locality, "Hogs-back," three hundred feet, west of Theological Seminary, in Allegheny-town. Geology, sandstone of the coal measures.

44. Philadelphia, April 26, 1841.

71° 59′	1	1*h*.30*m*.03*s*.2	1609.6	70°	1607.67	2584602.8289	917.11		
	2	2 11 02 8	1587.2	65 5	1585.95	2515237.4025	918.20		
	3	2 45 00 4	1291.6	67 5	1290.84	1666267.9056	916.63		
	4	3 16 03 2	1159.2	70	1158.45	1342006.4025	918.53		
	5	3 52 59 6	1412.	71 8	1410.83	1990441.2889	916.34		
	6	4 25 03 2	1406.	67 4	1405.89	1976526.6921	917.76		
						Mean,	917.43	2965.21	993.245

At twelve hours thirty-seven minutes. Cloudy, calm; clouds becoming thinner.

45. Trenton, N. J., Latitude 40° 13½′, N.; Longitude 74° 40′, W.; April 23, 1841.

71° 59′	4	1*h*.47*m*.58*s*.8	1156.	57°	1156.22	1336844.6884	922.08		
	5	2 16 03 2	1406.8	54 4	1407.35	1980634.0225	920.86		
	6	2 51 00 4	1402.	54	1402.75	1967707.5625	921.87		
						Mean,	921.60	2979.60	997.76

Soil alluvial, with a primitive substratum. Air damp and misty. Place, a woodland about three-fourths of a mile north of Trenton, near a streamlet, and just below a deserted turnpike road. Time noted by New York meridian.

46. Newark, New Jersey, Latitude 40° 43′, N; Longitude 74° 10′, W.; April 19, 1841.

72° 49′	1	10*h*.1 *m*.00*s*.4 A	1640.8	49°	1642.96	2699333.9912	878.13		
	2	10 42 01 6	1620.4	50 5	1622.63	2632928.1169	877.11		
	3	11 11 00 4	1320.	51	1320.68	1744195.6624	872.46		
	4	8 19 03 2	1182.	45 5	1183.11	1399749.2721	880.64		
	5	8 49 02 8	1439.6	45	1441.11	2076798.0341	878.13		
	6	9 24 04 4	1435.6	47 5	1437.17	2065486.3524	878.23		
						Mean,	878.45	2974.46	995.673

Time, by the meridian of Philadelphia.

Locality, "down the neck," in Morris's woods, so thick as to exclude the wind, which, with a clear sky, blew in strong gusts. Geology, probably sand underlaid

with sandstone in place, but with trap-rocks near. The above experiments were made on the eighteenth and nineteenth, and both the dip and horizontal intensity varied considerably. The last, as indicated by Nos. 4, 5, and 6, on the eighteenth, would be 879.00; and, by Nos. 1, 2, and 3, on the nineteenth, would be 876.23; a difference which corresponds to a change of dip equal to 3′ 37″. The dip observed on the eighteenth was 72° 52′, and that on the nineteenth, 72° 46′ which is a range of difference greater than that indicated by horizontal intensity, by 2′ 23″. It will be seen that I have taken the mean both of dip and intensity; but, by this note, I have put the reader in possession of all the facts. Still, I am not satisfied with the results at this locality. Will the stationary observers refer to their records for this time?

47. New York, Columbia College, April 19, 1841; Latitude 40° 43′, N.; Longitude 74° 01′, W.

Dip.	No of Needle	Epoch of commencing Vibrations.	Duration of 500 Vibrations.	Temperature.	Calculated duration at 60°.	Square of the Preceding.	Horizontal intensity.	Total intensity, Hor. being 1000.	Total intensity, that at Cincinnati being 1000.
72° 41′	1	4*h*.19*m*.59*s*.6 P	1643.2	55°	1644.18	2703327.8724	876.83		
	2	4 55 00 4	1614.4	54	1615.8	2610809.64	884.57		
	3	5 27 04 8	1315.2	55	1315.58	1730750.7364	882.47		
						Mean,	883.52	2969.20	994.282

Locality, the yard of the college, near the usual place of observation, which was pointed out to me by Professor Renwick. But, an iron fence having been erected on the outer side of the yard, it became necessary to remove to a place about central between that fence and the college building. Geology, deep diluvium, underlaid by gneiss rocks?

48. Near Harlaem, eight miles north-east of New York, April 20, 1841.

72° 21′	1	11*h*.44*m*.04*s*. A	1622.4	58° 1	1622.65	2632993.0225	900.26	2969.18	994.239.

Locality, about three hundred feet south-west of the new asylum for the insane, situated about one mile from Harlaem. Geology, gneiss rock, covered with soil, and an abundance of trappean bowlders, of large size. The dip was so extraordinary that, after vibrating one needle, I removed less than a mile, to the old asylum.

49. Old Asylum, near Harlaem, April 20, 1841.

72°39′36″	1	2*h*.09*m*.02*s*.8*	1635.2	57° 2	1635.78	2675776.2084	885.86		
	2	3 51 00	1618.4	54	1619.81	2623784.4361	880.20		
	3	2 48 03 6	1317.6	56	1317.09	1736860.41	879.37		
	4	3 20 59 2	1175.6	56	1175.9	1382740 81	891.47		
	5	4 21 59 6	1439.2	54	1439.8	2073024.04	879.83		
	6	4 50 00 8	1434.54	52 6	1435.47	2060574.1209	880.33		
						Mean,	882.84	2961.90	991.800

Locality, in a grove north-east of the old asylum. Geology, as above. Cloudy, wind south-east, sun-veiled, occasionally a little mist of fine rain.

50. Baltimore, Howard's Woods, April 28, 1841; Latitude 39° 17′, N.; Longitude 76° 37′, W.

71°34′06″	1	8*h*.18*m*.02*s*.	1589.2	54°	1590.34	2529181.3156	937.20		
	2	8 58 04	1569.6	54	1570.95	2467883.9025	935.80		
	3	10 05 03 6	1276.8	57 5	1277.	1630729.	936.60		
	4	10 40 00 8	1146.8	65 5	1146.64	1314783.2896	937.55		
	5	11 07 57 6	1396.8	65	1396.3	1949653.69	935.50		
	6	11 42 01 6	1390.4	64	1389.67	1931182.7089	939.31		
						Mean,	936.98	2963.53	993.48

* Mean time, New York meridian. On the supposition that the total intensity is the same at both the above localities, the horizontal intensity would indicate a difference of dip still greater than here exhibited. Making 72° 21′ the standard, the other would, by such calculation, be 72° 42′ 9″, instead of 72° 39′ 36″.

Locality, north-east of the Washington monument, and in the south-east corner of the woods.

51. Baltimore, St. Mary's College, April 28, 1841.

Dip.	No. of Needle.	Epoch of commencing Vibrations.	Duration of 500 Vibrations	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal intensity.	Total intensity, Hor. being 1000.	Total intensity, that at Cincinnati being 1000.
71°39′11″	1	3h.30m.02s.8 P	1598.	68°8	1596.31	2548205.6161	930.21		
	2	4 07 01 2	1574.8	65	1573.66	2476405.7956	932.58		
	3	4 44 05 4	1279.6	63	1279.38	1636813.1844	933.12		
	4	5 17 02 0	1150.	64 5	1149.66	1321718.1156	932.63		
	5	5 48 02 8	1400.	59	1400.1	1960280.01	930.43		
	6	6 15 58 4	1394.	54 5	1394.67	1945104.4089	932.58		
						Mean,	931.92	2953.82	991.399

Locality, in the midst of the botanical garden of St. Mary's College. Clear, fine, gentle north-west wind. Substratum, primitive rocks. Although Howard's woods and St. Mary's College are less than a mile apart, the local differences are very considerable, and might throw some degree of discredit on the results, were it not that the facts are too well established by independent observers. At both the above localities, Mr. Nicollet made observations, to determine the dip, on the same day, and nearly on the same hours, with a similar apparatus, manipulating, at my request, in the mode which I had adopted. The results were remarkably coincident, as have been others at the same localities. The results are contrasted below:—

AT HOWARD'S WOODS.		ST. MARY'S COLLEGE.	
By Professor Bache, August 24, 1840, dip =	71° 34′ 4″	Professor Bache did not observe at this place.	
By Professor Locke, April 28, 1841,	71 34 3	By Professor Locke, April 28, 1841, dip =	71° 39′ 2″
By Mr. Nicollet, April 28, 1841,	71 34 9	By Mr. Nicollet, April 28, 1841,	71 38 6
By Major Graham, June 10, 1841,	71 31 9	By Major Graham, June 11, 1841,	71 38 8

Those who endeavour to maintain that magnetical dip cannot be very nearly measured by good instruments, carefully used, will find it difficult to account for such a coincidence as is exhibited above. Other localities in the neighbourhood of Baltimore will probably exhibit equal, or perhaps greater, differences than the above.

Bristol, Pennsylvania, Latitude 40° 09′, N.; Longitude, 74° 47′, W.; April 14, 1841.

Dip 72° 27′ 30″. No experiments were made here to ascertain intensity; but, in 1842, (see the series for that year,) that point was determined.

Locality, Professor Vanuxem's, on the bank of the canal. Geology, deep diluvial gravel and clay (?) underlaid by primitive rocks. It will be observed that the dip here is greater than at Philadelphia or Trenton.

V. SERIES, FOR 1842, CINCINNATI TO CAMBRIDGE, (MASSACHUSETTS.)

The intensities at Cincinnati, May 8, 1841, being assumed as unity.

52. Cincinnati, March 31, 1842.

70°20′20″	1	1h.40m.04s.8 A							
	2	10 28 02 4	1536.8	52°	1538.2	2366059.24	1001.82		
	3	10 58 02	1516.4	54	1517.7	2303413.29	1002.62		
	4	11 41 00	1236.	54 5	1236 3	1528684.96	999.13		
	5	12 22 02 4 P	1350.8	55 5	1351.02	1825741.44	999.00		
	6	12 51 59 2	1346.4	57	1346.75	1813735.5625	1000.13		
						Mean,	1000.54	2973.72	996.19

The dip is here so unusual, that I shall use the observations made May 8, 1841, to furnish the unit for the following series.

53. Cincinnati, May 8, 1841.

(See series for 1841.)	1000.	2986.38	1000.
	Logarithm,	1.4751456	

54. Pittsburgh, Latitude 40° 32′, N.; Longitude 80° 02′, W.; April 7, 1842.

Dip.	No. of Needle.	Epoch of commencing Vibrations.	Duration of 500 Vibrations	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal intensity.	Total intensity, Hor. being 1000.	Total intensity, that at Cincinnati being 1000.
72°43′12″	1	4h.39m.0s.16 P	1634.4	74°	1631.70	2662444.89	890.29		
	2	3 13 02 4	1612.8	73	1609.8	2591456.04	891.18		
	3	5 47 03 2	1299.2	71	1698.4	1685842.56			
						Mean,	890.73	2998.64	1004.10

Locality, as in previous series.

55. Chambersburg, Pennsylvania, Latitude 39° 55′, N.; Longitude 77° 40′, W.; April 9, 1842.

71°57′04″	1	1h.05m.03s.6	1605.6	73° 5	1602.1	2566724.41	923.49		
	2	1 39 06 4	1585.6	71 0	1583.1	2506205.61	921.49		
	3	2 11 59 6	1289.2	68 5	1288.6	1660489.96	919.82		
	4	2 42 30	1156.4	67 0	1155.9	1336104.81	922.59		
	5	3 10 02 8	1407.6	65 0	1407.1	1979930.41	921.19		
	6	3 43 02 8	1404.0	64 0	1403.5	1969812.25	920.88		
						Mean,	921.57	2975.52	996.36

Half a mile west and a little south of the court house, and five hundred feet south of the stream, just on top of second bank, in a woodland. At two hours thirty minutes had become hazy, wind north-west, gentle. Substratum, dark-blue limestone, highly inclined.

56. Mount St. Mary's College, Emmetsburg, Latitude 39° 41′, N.; Longitude 77° 18′, W.; April 12, 1842.

71°46′20″	1	8h.57m.02s.8 A	1596.4	66°	1595.3	2544982.09	931.39		
	2	4 05 02 4 P	1574.8	72	1572.0	2471184.00	934.55		
	3	10 03 04 A	1280.8	70	1280.	1627920.81	932.39		
	4	9 09 03 6	1150.4	58	1150.7	1324110.49	930.95		
	5	8 25 01 2	1399.6	64 8	1399.1	1957480.81	931.76		
	6	7 51 02	1394.8	61	1394.7	1945208.09	932.52		
						Mean of 5 needles,	931.90	2979.26	997.66

On the left bank of a brook, which, descending the mountain, passes the college. Indurated or metamorphic sandstone.

57. New Haven, Latitude 41° 18′, N.; Longitude 72° 56′, W.; April 21, 1842.

73°29′47″	4	7h.23m.03s.2 A	1211.2	50°	1212.00	1468944.	839.16		
	5	7 56 03 6	1475.2	52 5	1476.00	2178576.	837.20		
	6	8 30 02 4	1469.6	55 7	1470.15	2161341.0225	839.27		
						Mean,	838.54	2951.82	988.44

At a locality called "Highwood," a part of the Hillhouse estate. Substratum, sandstone; trappean rocks within a few miles.

58. Boston, Latitude 42° 22′, N.; Longitude 70° 59′, W.; May 2, 1843.

Dip.	No. of Needle.	Epoch of commencing Vibrations.	Duration of 500 Vibrations.	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal intensity.	Total intensity, Hor. being 1000.	Total intensity, that at Cincinnati being 1000.
74°05′40″	1	6h.04m.03s.2 A	1712.4	55°	1713.43	2935842.2649	807.39		
	2	6 45 04 4	1691.6	51 5	1693.68	2868551.9424	805.09		
	3	7 53 10	1377.2	54	1377.58	1897726.6504	804.83		
	4	12 13 01 2 P	1236.4	61	1236.32	1528487.1424	806.47		
	5	12 44 03 6	1504.4	54	1505.03	2265115.3009	805.21		
	6	1 15 00	1500.0	54	1500.79	2252370.6241	805.36		
						Mean,	805.72	2940.02	984.47

Locality, in the garden of the Coolidge House, Bowdoin square. Geology, deep diluvium.

59. Cambridge Observatory, May 4, 1842.

74°14′52″	1	11h.42m.03s.6 A	1714.	48°	1716.5	2946372.25	804.50		
	2	12 20 00 P	1694.8	48	1697.7	2882185.29	801.28		
	3	2 00 04 4	1378.4	50	1379.2	1902192.64	802.94		
	4	2 33 04 4	1234.8	50	1235.6	1526707.36	807.49		
	5	3 05 04 4	1505.6	51 5	1506.5	2269572.25	803.63		
	6	3 43 04 8	1500.8	52 5	1501.8	2255403.24	804.28		
						Mean,	804.02	2961.64	991.71

In the Magnetical Observatory of Mr. Bond. Deep diluvium, superimposed on gneisse rocks. (?)

60. Bristol, Pennsylvania, Latitude 40° 06′, N.; Longitude 74° 47′, W.; May 13, 1843.

72°25′20″	1	7h. 7m.00s.2 P	1634.4	65°	1633.4	2667995.56	888.45	2941.56	984.99

In the middle of Professor Vanuxem's garden. Diluvium of clay, sand, and gravel, superimposed on primitive rocks.

61. Philadelphia, Magnetical Observatory, May 15, 1842.

72° 01′	1	1h.52m.04s.8 P	1608.8	66°	1608.03	2585760.4809	916.70		
	2	2 36 59 6	1585.2	56 5	1586.01	2515396.	918.13		
	3	3 24 02	1290.4	52 5	1291.00	1666681.	916.40		
	4	3 55 00 4	1156.4	52	1157.00	1338649.	920.83		
	5	4 25 00 0	1409.3	53	1410.30	1988946.09	917.02		
	6	5 00 58 8	1404.4	52 5	1405.30	1974868.09	918.02		
						Mean,	917.85	2972.88	995.48

At the Observatory, near the Girard College. Rain commenced about the close of the observations. There is a very close coincidence of the above observations and those made in March, of the preceding year, both in the details and in the mean results. The horizontal intensity of 1841 was 917.84 and 917.11, and, as above, in 1842, 917.85.

VI. SERIES, 1843, CINCINNATI, (OHIO,) TO MICHIGAN, AND WISKONSIN, LAKE SUPERIOR.

63. Cincinnati, August 21, 1843.

70°25′30″	4	11h.17m.00s. A	1110.8	74°	1109.52	1231034.6304	1001.33		
	5	11 48 03 6	1352.8	75	1351.16	1825633.3456	999.05		
	6	12 31 00 0 P	1347.6	75 5	1345.55	1810504.8025	1001.91		
						Mean,	1000.76	2986.98	1000.20

The above being a comparison of the results obtained at the above date with those of May 8, 1841, assumed as unity, or, rather, as 1000, exhibit very favourably the permanency of the magnetism of the needles; and show it to be quite immaterial which, hereafter, be made the standard of comparison—the observations of May 8, 1841, or those of August 21, 1843. The following calculations will be made by using the above squares as dividends, and will, therefore, refer to Cincinnati, August 21, 1843, as unity. The observations were made at the usual locality, in Longworth's garden. Weather clear and calm.

64. Huron, Ohio, Latitude 41° 21′, N.; Longitude 82° 27′, W.; June 6, 1843.

Dip.	No. of Needle	Epoch of commencing Vibrations.	Duration of 500 Vibrations.	Temperature.	Calculated duration at 60°.	Square of the Preceding.	Horizontal intensity.	Total intensity, Hor. being 1000.	Total intensity, that at Cincinnati being 1000.
73°00′00″	4	9*h*.41*m*.02*s*.4 A	1180.0	63°5	1179.41	1391007.9481	884.99		
	5	10 28 04 0	1440.0	66 5	1439.11	2071037.5921	881.50		
	6	11 16 04 0	1432.8	69 5	1431.36	2048791.4496	883.69		
						Mean,	883.40	3021.50	1012.32

Locality, the low peninsula on the east side of the mouth of the Huron river. The immediate soil is diluvium, but, at no great depth, the "black shale" must exist.

65. Detroit, (Michigan,) Latitude 42° 25′, N.; Longitude 82° 56′, W.

73° 32′	4	8*h*.21*m*.02*s*.4 A	1200.	66°5	1199.3	1438320.4900	855.88		
	5	8 48 03 2	1462.	68 0	1460.94	2134345.6836	855.36		
	6	9 22 01 2	1456.4	72 0	1454.63	2115948.4369	855.64		
						Mean,	855.63	3018.55	1011.34

Near the Pontiac rail-road, about one-fourth of a mile north of the bend. Ancient lake bed, similar to a diluvium. Surface level and wet. Substratum, at, perhaps, one hundred feet below the surface, the cliff limestone. Clear, fine, wind south-west.

66. Ann Arbor, (Michigan,) Latitude 42° 16′, N.; Longitude 83° 39′, W.; June 13, 1843.

73°12′36″	4	6*h*.29*m*.02*s*.0 P	1185.2	71°5	1184.12	1402140.1744	877.96		
	5	6 59 01 2	1443.6	68 0	1442.56	2080979.3536	877.77		
						Mean,	877.86	3039.00	1018.20

In the woods south-east of the university. Geology, diluvium of large bowlders. On the supposition of equal intensities at Ann Arbor and at Detroit, the calculated dip at the former place would be 73° 07′ 30″, 5′ 06″ less than the observed dip.

67. Ann Arbor, June 14, 1843.

73°14′46″	6	6*h*.07*m*.59*s*.2 A	1437.2	57°5	1437.28	2065773.7984	876.43	3040.40	1018.64

About three hundred feet east of the previous locality.

68. Detroit, Chancellor Farnsworth's Garden, June 15, 1843.

73°32′25″	4	3*h*.05*m*.00*s*.5 P	1200.2	67°	1199.45	1438680.3025	855.67		
	5	3 36 04 0	1462.8	66	1462.00	2137444.0000	854.11		
						Mean,	854.89	3017.17	1010.90

Geology, deep lacustrine deposite, underlaid by the cliff limestone. Cloudy, and a slight, misty rain towards the end of the time.

69. Mackinaw Island, Latitude 45° 54′, N.; Longitude 84° 10′, W.; June 18, 1843.

Dip.	No. of Needle.	Epoch of commencing Vibrations.	Duration of 500 Vibrations	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal intensity.	Total intensity, Hor. being 1000	Total intensity, that at Cincinnati being 1000.
76°38′51″	4	9h.18m.03s.6 A	1312.0	71°5	1310.8	1718196.6400	716.47		
	5	10 00 04 8	1599.6	75 0	1597.66	2552517.4756	715.23		
	6	10 49 00 0	1593.2	79 0	1590.28	2528990.4784	715.90		
						Mean,	715.87	3100.4	1038.75

About three hundred yards west of the highest point of the island. Geology, the cliff limestone, very much disturbed and broken. Clear, calm, beautiful. Some calm cirri.

70. Sault de St. Marie, Latitude 46° 31′, N.; Longitude, 84° 32′, W.

77°30′15″	4	11h.55m.02s. A	1359.6	86°	1357.08	1841666.7264	668.43		
	5	12 29 06 P	1655.2	89	1651.57	2727683.4649	669.29		
	6	1 05 06	1647.6	90	1643.00	2699449.0000	670.69		
						Mean,	669.47	3094.10	1036.65

About four hundred yards west of the mill-race, and near the proposed canal around the Sault. Geology, diluvium, superimposed on horizontally stratified sandstone.

71. Encampment about ten miles below St. John's River, Lake Superior; Latitude 46° 44′, N.; Longitude 87° 43′, W.; July 2, 1843.

76°58′19″	4	8h.06m.04s. A	1330.	60°	1329.78	1768314.8484	696.16		
	5	8 59 00	1620.	60	1619.73	2623525.2729	695.87		
	6	9 35 08	1613.6	61	1613.2	2602414.2400	695.70		
						Mean,	695.91	3087.10	1034.10

In a swamp of cedar, fir, and white birch trees, underlaid by horizontally stratified sandstone, but with trappean rocks not far distant both ways on the lake shore.

At this locality, a small island, distant about three miles, bears north 69° east, and, another, distant half of a mile, bears north 7° west. The last is so near the shore as to leave a channel not more than one hundred and twenty yards wide. A small rivulet puts in between our encampment and the point opposite this island. Clear, wind north-west, strong.

72. Houghton's River, near Copper Harbour, Latitude 47° 28′, N.; Longitude 88° 01′, W.; July 8, 1843.

77°20′45″	4	12h.38m.02s.4 P	1356.0	71°5	1354.77	1835401.7529	670.71		
	5	1 15 01 6	1650.8	72 0	1648.35	2717657.7225	671.91		
	6	2 00 04 8	1644.4	72 0	1642.4	2697477.7600	671.18		
						Mean,	671.27	3064.30	1026.62

This locality is designated on the map by a circlet and the letter *a*. Substratum, metamorphic conglomerate, approaching, apparently, to trap rock in its nature. Clear, wind north-west.

73. Magnet Inlet, Porter's Island, Copper Harbour, Latitude 47° 29′ N.; Longitude 88° 02′ W.; July 8, 1843.

78°45′20″	4	11h.48m.02s.4 A	1411.2	62°	1410.8	1990356.64	618.50		
	5	12 21 00 4 P	1717.6	60	1717.32	2949187.9824	619.03		
	6	1 10 04 8	1709.6	58	1709.00	2920681.0000	619.89		
						Mean,	619.14	3175.10	1063.80

This station is designated, on the map of Porter's Island, as station No. 7. Wind north-west, strong.

74. Magnet Inlet, July 11, 1843.

Dip.	No. of Needle.	Epoch of commencing Vibrations.	Duration of 500 Vibrations.	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal intensity.	Total intensity, Hor. being 1000.	Total intensity, that at Cincinnati being 1000.
78°45′20″	4	6*h*.28*m*.04*s*. P	1408.4	66°	1407.62	1981394.0644	621.29		
	5	6 54 00	1716.0	61 5	1715.54	2943077.4916	620.31		
	6	Not used.				Mean,	620.80	3183.62	1066.66

The geology, &c., of this locality will be discussed after we shall have presented all of the observations made about Copper Harbour.

75. Five hundred feet east of Magnet Inlet, July 15, 1843.

78°37′30″	4	4*h*.37*m*.00*s*. P	1406.	74°	1404.5	1972620.2500	624.06		
	5	5 00 04 4	1712.	68	1710.77	2926733.9929	623.77		
	6	5 32 01 6	1706.	66	1704.82	2906411.2324	622.93		
						Mean,	623.59	3160.70	1059.31

In a grove of small spruce and fir trees. Station 8, on map of Porter's Island.

76. On the Isthmus between the lower end of Copper Harbour and the "White rock," July 11, 1843; Latitude 47° 29′, N.; Longitude 88° 00′, W.

78° 28′	4	10*h*.48*m*.00*s*. A	1399.6	71°	1398.37	1955438.6569	629.54		
	5	11 22 04 4	1704.0	72	1703.30	2901230.8900	629.26		
	6	12 01 04 0	1696.0	71	1694.08	2869907.0464	630.86		
						Mean,	629.88	3150.38	1055.50

Substratum, metamorphic conglomerate. The experiments were made in the shadow of the trunk of a dead tree.

77. Near General Cunningham's Office, and eleven hundred feet westwardly of Magnet Inlet, on Porter's Island, July 8, 1843. Station No. 3.

77°13′30″	4	6*h*.53*m*.00*s*.8 P	1309.6	58°	1309.56	1714947.3936	717.82		
	5	7 23 03 6	1596.	55	1596.3	2548173.69	716.44		
	6					Mean,	717.13	3243.20	1086.58

It appears from the preceding that there are great variations of the magnetic elements on, and about, Porter's Island, within very small distances. The mean of the total intensity at five different stations, about Copper Harbour, will be 3158.90, as follows:

1. At Houghton's River,	3064.30
2. At Magnet Inlet,	3175.10
3. Five hundred feet east of Magnet Inlet,	3160.70
4. Isthmus of the White Rock,	3151.00
5. Near the Agency Office,	3243.20
Mean,	3158.90

Assuming the above mean as the total intensity at (Copper Harbour) Magnet Inlet, we have by the horizontal intensity given above, "619.14," and, by the application of the formulæ already given, the calculated dip 78° 41′ 49″, within 3′ 31″ of the observed dip at the same locality. Thus the unusual dip at this place is proved by two sets of direct observations, and by the vibrations of three intensity needles, also twice repeated.

In order to examine, more in detail, the changes of the dip in various parts of the island, I selected that needle, (No. 2,) and the mode of using it, which gave, at a single

observation, a result nearest to the mean of a complete series, and with it ascertained the dip at several localities noted on the map of Porter's Island, beginning at the extreme western end as follows:

Station No. 1,	77° 10′	+ 7′	=	77° 17′	
" " 2,	77 07	+ 7	=	77 14	
" " 3,				77 13 30″	Complete Series at General Cunningham's Office.
" " 4,	77 13.5	+ 7	=	77 20 30	
" " 5,	77 20	+ 7	=	77 27	
" " 6,	77 35	+ 7	=	77 42	
" " 7,	78 38	+ 7	=	78 45	
" " 8,				78 37 30	A full series.
" " 9,	78 25	+ 7	=	78 32	
		Mean,		77° 47′	

Here, between the sixth and the seventh station, a distance of only four hundred and twenty feet, there is an increase of the dip to the extent of 1° 02′!

78. Mouth of Eagle River, Latitude 47° 27′, N.; Longitude 88° 23′, W.; July 13, 1843.

Dip.	No of Needle.	Epoch of commencing Vibrations.	Duration of 500 Vibrations.	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal intensity.	Total intensity, Hor being 1000	Total intensity, that at Cincinnati being 1000.
77°54′30″	4	10*h*.26*m*.59*s*.6 A	138.0	81°	1378.	1898884.0000	648.29		
	5	12 33 59 6 P	1681.2	88 5	1678.75	2818201.5625	647.80		
	6	12 02 02 8	1674.8	85 0	1670.85	2791739.7225	648.52		
						Mean,	648.20	3094.40	1036.72

On the sandy beach at the mouth of a small river. As it was raining at the commencement of the experiments, they were made within the tent, upon which the sun shone, as soon as the clouds and fog disappeared. Substratum, probably metamorphic conglomerate.

79. La Pointe, Magdalene Island, W. T., Latitude 46° 47′, N.; Longitude 90° 58′, W.; July 21, 1843.

76°56′07″	4	10*h*.48*m*.02*s*. A	1324.2	80° 0	1320.28	1743139.2784	706.21		
	5	11 19 05 6	1613.2	85 0	1610.12	2592486.4144	704.20		
	6	11 56 02 8	1608.	83 5	1604.4	2574099.3600	703.74		
						Mean,	704.72	3117.5	1044.50

About half a mile eastwardly of the mission house, amongst the shady evergreens. Geology, lacustrine diluvium superimposed on sandstone.(?) Clear, wind south, unusually warm for the climate.

80. Ontonagon River, Latitude 46° 52′, N.; Longitude 89° 31′, W.; July 26, 1843.

77°13′10″	4	6*h*.27*m*.59*s*.6 A	1340.	64°	1339.43	1794072.7249	686.17	3101.81	1039.23

On the east side of the mouth of the river. Alluvium, superimposed on sandstone. Clear, wind north-west.

81. Rock Harbour, Isle Royale, Latitude 48° 06′, N.; Longitude 88° 47′, W.; July 28, 1843.

78°07′36″	4	6*h*.29*m*.04*s*.4 P	1380.4	60°	1380.17	1904869.2289	646.25		
	5	7 52 00 8	1680.4	58	1680.35	2823576.1225	646.56		
						Mean,	646.40	3141.70	1052.60

On the north side of the harbour, in a small opening amongst the fir trees, growing almost without soil, on a metamorphic sand rock, approaching, in its character, to trap rock.

82. Near Cleveland, Ohio, at Professor Kirtland's, Latitude ; Longitude ; August 4, 1843.

Dip.	No of Needle	Epoch of commencing Vibrations.	Duration of 500 Vibrations	Temperature.	Calculated duration at 60°.	Square of the Preceding.	Horizontal intensity.	Total intensity, Hor. being 1000.	Total intensity, that at Cincinnati being 1000.
73° 08′	5	3*h*.52*m*.04*s*.4 P	1442.	80°	1439.74	2072851.2676	880.74		
	6	4 30 01 2	1436.8	77	1434.68	2058306.7024	879.60		
						Mean,	880.17	3033.54	1016.34

Near the lake, in a woodland. Substratum, the "black shale."

As the intensity at Copper Harbour is evidently high, compared with that which shows itself at the other localities along the south shore of the lake, it is proper, perhaps, to make a group of all the others, excluding those of the harbour, as from one to five, inclusive, in the following table.

SUMMARY, BY GROUPING.

Title of the Group	Names of Places.	Latitude.	Longitude.	Dip.	Total Intensity. LOCKE.	Total Intensity. SABINE.
Five Stations of the South Shore.	1. Sault St. Marie,	46° 31′	84° 32′	77°30′15″	1036.65	
	2. Encampment,	46 44	87 43	76 58 19	1034.10	
	3. Mouth of Eagle River,	47 27	88 23	77 54 30	1036.72	
	4. Mouth of Ontonagon,	46 52	89 31	77 13 10	1039.23	
	5. Lapointe,	46 47	90 58	76 56 00	1044.50	
	Mean of the above,	46°52′12″	88°08′36″	77°18′27″	1038.24	1882.64
Five Stations at Copper Harbour.	6. Houghton's River,	47 28	88 01	77 20 45	1026.62	
	7. Magnet Inlet, (7)	47 29	88 01	78 45 20	1065.23	
	8. 500 ft.E.of Mag.Inlet,(8)	47 29	88 01	78 37 30	1059.31	
	9. Isthmus,	47 29	88 00	78 28 00	1055.50	
	10. United States Agency,	47 29	88 01 10	77 13 30	1086.58	
	Mean of the above,	47°28′48″	88°00′50″	78°05′01″	1058.65	1919.65
	11. Isle Royale,	48 06	88 47	78 07 36	1052.60	1908.08
	Mean of all the above observations on Lake Superior,	47°15′32″	88°10′43″	77°44′00″	1048.82	1901.82

The following table exhibits the total intensity of several of the most important places, expressed, both in the values referred to Cincinnati, and in those used by Colonel Sabine.

Stations.	Latitude.	Longitude.	Dip.	Total Intensity. Cincinnati 1000.	Total Intensity. SABINE.	Observer.	Year.
Casmar, South America, - - - -	9°38′ S.	78°85	5°00′ S.	551.40	1000.00	Humboldt	1802
New York, - - - - - - - - -	40 43 N.	74 01	72 41 N.	994.30	1803.00	Locke	1841
Cincinnati, - - - - - - - - -	39 06	84 22	70 27 00	1000.00	1813.30	"	1841
Williamstown, Kentucky, - - - -	38 36	84 22	70 04 07	993.25	1801.06	"	1840
St. Louis, Missouri, - - - - -	38 36	90 15	69 31 26	997.35	1808.35	"	1839
Davenport, Iowa, - - - - - -	41 30	90 35	71 55 00	1012.91	1836.71	"	1839
Mean of five stations on the South Shore,	46 52 12	88 08 36	77 18 27	1038.24	1882.64	"	1843
Five stations on Copper Harbour, L. S.,	47 28 48	88 00 50	78 05 01	1058.65	1919.65	"	1843
Isle Royale, - - - - - - - -	48 06	88 47	78 07 36	1052.60	1908.08	"	1843
Mean of all the stations on Lake Superior,	47 15 32	88 10 43	77 44 00	1048.82	1901.82	"	1843

COMPARISON OF THE INTENSITIES, AS GIVEN IN THE PRECEDING TABLES, WITH THOSE REPORTED TO THE BRITISH ASSOCIATION IN 1838, BY MAJOR SABINE, R.A.

In Major Sabine's Report the intensity of some place near the equator, as observed by Humboldt, in 1802, has been assumed as unity, and, on page forty-three, we find that of New York to be 1803.0. By the unit assumed in the above tables, the intensity at the same locality, Columbia College, New York, is expressed by 994.3. Then we have (Locke,) 994.3 : (Sabine,) 1803.0 : : (Locke,) 1000 : (Sabine,) 1813.3, the last being the intensity at Cincinnati, according to Colonel Sabine's unit. Hence to reduce any total intensity, a, given in the preceding tables, where that at Cincinnati is assumed as unity, to a comparison with the standard or unit assumed by Major Sabine, we have the following formula: $\frac{18133}{10000}\,a = x$, the required value. By the application of this formula to the intensity observed on Porter's Island, in Lake Superior, 1086.58, we obtain 1970.29. Situated, as this locality is, nearly in the centre of the great ellipsoid described by Major Sabine in his plates, Nos. 3 and 4, by the lines representing the intensities 1.700 and 1.800, and being the highest magnetical intensity yet observed on the earth, so far as known to me, we deem the observations worthy of peculiar attention. But the more correct result will be obtained, not by an extreme instance, but by the mean of a group, as that of the five stations given on a previous page, "3158.90," which, reduced to the Cincinnati standard of unity, becomes 1058.02, and, reduced again by the above formula, to Colonel Sabine's standard, is equal to 1918.5, or, as it is pointed on Colonel Sabine's charts, 1.9185. By a similar reduction of the temperature at Isle Royale, we have 1.90808. As the intensity at Copper Harbour is evidently high, compared with that which shows itself at the other localities along the south shore of the lake, it is proper, perhaps, to make a group of all the others, excluding those of the Harbour.

It appears, by the intensity at Cincinnati and Williamstown, in Kentucky, that the isodynamic line of New York passes between those two places, about twenty-five geographic miles south of Cincinnati, and five north of Williamstown. By a calculation of the change of intensity proportional to change of latitude, from Davenport to St. Louis, it appears that the same isodynamic line crosses the Mississippi at a point thirty-two geographic miles south of St. Louis, namely, in latitude 38° 04′, north.

From Lexington, in Kentucky, to Isle Royale the difference of latitude is exactly ten degrees; and the difference of intensity, according to my unit, is 67.18, or, 6.718 to each degree. According to Colonel Sabine's unit, the whole difference will be 0.12122, or, 0.012122 to each degree.

GENERAL SUMMARY.

I. SERIES, FOR OHIO, 1838.

No.	Date.	Place.	Latitude.	Longitude.	Dip.	Horizontal Intensity.	Total intensity Hor. being 1000.	Horizontal Intensity	Total Intensity by Sabine's unit
1	March 20,	Cincinnati, - - - -	39° 06′ N.	84°22′W.	70°28′08″	1000.	2991.1	1000.	1.8138
2	" 26,	Dayton, - - - - -	39 44	84 17	71 22 42	958.20	3001.0	1003.2	
3	" 29,	Springfield, - - - -	39 54	83 51	71 27 23	949.4	2984.3	997.8	
4	" 30,	Urbana, - - - - -	40 05	83 48	71 39 45	953.26	3027.9	1012.2	
5	April 2,	Columbus, - - - -	39 57	83 02	71 04 52	966.64	2981.3	996.72	

II. SERIES FOR IOWA, &c., 1839.

No.	Date.	Place.	Latitude.	Longitude.	Dip.	Horizontal Intensity.	Total Intensity, Hor. being 1000.	Total Intensity.	Total Intensity by Sabine's unit.
6	Aug. 18, 1840,	Cincinnati, - - - -	39°06′	84°22′	70°27′26″	1000.	2989.40	1000.	1.81330
7	Sept. 6,	St. Louis, - - - -	38 36	90 02	69 31 26	1042.97	2981.50	997.35	1.80849
8	" 13,	Davenport, - - - -	41 30	90 25	71 55	939.90	3028.03	1012.91	1.83671
9	" 15,	Davenport, - - - -	41 30	90 27	71 55 15	937.92	3021.32	1011.00	
10	" 23,	Lost Grove, - - - -	41 39	90 09	72 02 26	935.96	3028.46	1015.39	
11	" 25,	Wapsipinnicon, - -	41 44	90 23	72 15 00	930.16	3051.06	1020.61	
12	" 27,	Iron Ore Bed, - - -	41 55	90 40	72 50 30	908.52	3079.59	1030.16	
13	" 30,	Brown's Settlement, -	42 02	91 06	72 21	918.11	3028.05	1012.92	
14	Oct. 2,	Makoqueta, - - - -	42 14	90 57	72 43 37	903.41	3042.57	1017.77	
15	" 5,	Farmer's Creek, - -	42 13	90 23	72 36	914.36	3057.64	1022.82	
16	" 8,	White Water, - - -	42 18	90 38	72 55	892.70	3038.85	1016.53	
17	" 9,	N. B. Makoqueta, - -	42 23	90 52	72 51	889.71	3017.25	1009.31	
18	" 14,	Dubuque, - - - -	42 29	90 23	73 05	880.55	3028.66	1013.00	
19	" 20,	Forks of Little Makoqueta,	42 31	90 31	73 08	881.27	3037.34	1016.02	
20	" 22,	Turkey River, - - -	42 42	90 48	73 11	873.19	3018.18	1009.	
21	" 24,	Prairie du Chien, - -	43 01	90 53 30	73 16 35	876.34	3045.44	1018.73	
22	" 29,	Blue Mound, (W. T.,)	43 01	89 38	73 41	854.00	3038.54	1017.43	
23	Nov. 2,	Madison, (W. T.,) - -	43 05	89 06	74 03	852.06	3102.25	1037.76	
24	" 5,	Mineral Point, - - -	42 50	89 54	73 20 37	868.60	3030.40	1013.70	
25	Sep. 24, 1840,	Cincinnati, - - - -	39 06	84 22	70 29 11	998.12	2984.40	998.31	
Mean, excluding Cincinnati & St. Louis,			42°18′10″	90°37′38″	72°50′			1017.38	

III. SERIES OF 1840, OHIO, KENTUCKY, &c.

26	Aug. 18,	Cincinnati, - - - -	39°06′	84°22′	70°27′26″	1000.	2989.40	1000.	
27	" 20,	Hamilton, Ohio, - -	39 23	84 32	70 58	978.33	2999.90	1003.50	
28	" 21,	Dayton, Ohio, - - -	39 44	84 17	71 22	954.40	2987.10	999.15	
29	" 22,	Piqua, Ohio, - - -	40 06	84 13	71 35 50	946.10	2997.30	1002.60	
30	" 24,	Lebanon, Ohio, - - -	39 26	84 06	71 02 45	972.04	2993.63	1001.07	
31	" 25,	Mason, Ohio, - - -	39 22	84 13	70 54 12	976.96	2986.16	998.90	
32	" 26,	Cincinnati, - - - -	39 06	84 22	70 27 54	997.03	2981.74	997.43	
33	Sept. 1,	Williamstown, Kentucky,	38 36	84 22	70 04 07	1012.20	2969.27	993.25	
34	" 2,	Lexington, Kentucky, -	38 06	84 18	69 54 30	1012.00	2945.94	985.42	1.78686
35	" 3,	Clay's Ferry, Kentucky,	37 54	84 18	69 49 00	1020.35	2957.32	989.27	
36	" 4,	Frankfort, Kentucky, -	38 14	84 40	69 54 53	1015.06	2954.76	988.74	
37	March 11,	Louisville, Kentucky, -	38 03	85 30	69 54 26	1023.38	2978.90	996.48	
38	Sept. 10,	Vernon, Indiana, - -	37 57	87 47	68 56 17	1064.61	2964.51	991.33	
39	" 11,	New Harmony, - -	38 11	87 48	69 03 37	1058.10	2961.80	990.76	
40	" 16,	Princeton, Indiana, - -	38 23	87 30	69 22 48	1044.68	2966.40	992.29	
41	" 18,	Vincennes, Indiana, -	38 43	87 25	69 51 10	1026.03	2978.89	998.54	
42	" 20,	Paoli, Indiana, - - -	38 35	86 25	69 33 47	1031.84	2953.68	988.04	
43	" 24,	Cincinnati, - - - -	39 06	84 22	70 29 11	996.88	2984.40	998.31	
Mean, including Cincinnati but once,			38°45′42″	85°21′37″	70°11′			995.00	

IV. SERIES, 1841, CINCINNATI.

44	May 8,	Cincinnati, - - - -	39° 06′	84° 22′	70°26′11″	999.58	2983.88	*998.56
45	" 8,	Cincinnati, - - - -	39 06	84 22	70 26 11	1000.	2986.38	1000.*
46	March 30,	Philadelphia, - - -	39 57	75 10	72 00 10	917.84	2970.80	994.78
47	" 31,	Philadelphia, - - -	39 57	75 10	72 01 20	917.11	2971.38	994.97
48	" 22,	Pittsburgh, - - - -	40 32	80 02	72 43 30	891.47	3002.00	1005.23	
49	April 26,	Philadelphia, - - -	39 57	75 10	71 59	917.43	2965.21	994.32	
50	" 23,	Trenton, New Jersey,	40 13	74 40	71 59	921.60	2979.60	997.76	
51	" 19,	Newark, New Jersey,	40 43	74 10	72 49	878.45	2974.46	995.67	
52	" 19,	New York, - - - -	40 43	74 01	72 41	883.52	2969.20	994.28	
53	" 20,	Harlaem, - - - -	40 49	74	72 39 36	882.84	2961.90	991.80	
54	" 20,	New Asylum, - - -	40 48		72 21	900.26	2969.18	994.24	
55	" 28,	Baltimore, - - - -	39 17	76 37	71 34 06	936.98	2963.53	993.48	
56	" 28,	Baltimore, - - - -	39 17	76 37	71 39 11	931.92	2953.82	991.40	

* That of August 18, 1840, being assumed as unity in this series.

V. SERIES, 1842, CINCINNATI TO CAMBRIDGE, (MASSACHUSETTS.)

No.	Date.	Place.	Latitude.	Longitude	Dip.	Horizontal Intensity	Total Intensity, Hor being 1000.	Total Intensity.	Total Intensity by Sabine's unit.
57	March 31,	Cincinnati, - - - -	39° 06′	84° 22′	70°20′20″	1000.54	2973.72	996.19	
58	My.8,'41,	Cincinnati, - - - -	39 06	84 22	70 26 11	1000.	2986.38	1000.	
59	Ap.7,'42,	Pittsburgh, - - - -	40 32	80 02	72 43 12	890.73	2998.64	1004.10	
60	April 9,	Chambersburg, - - -	39 55	77 40	71 57 04	921.57	2975.52	996.36	
61	" 12,	Mt. St. Mary's College,	39 41	77 18	71 46 20	931.90	2997.26	997.66	
62	" 21,	New Haven, - - -	41 18	72 56	73 29 47	838.54	2951.82	995.18	
63	May 2,	Boston, - - - - -	42 22	70 59	74 05 40	805.72	2940.02	984.47	
64	" 4,	Cambridge, - - - -			74 14 52	804.02	2961.64	991.71	
65	" 13,	Bristol, - - - - -	40 06	74 47	72 25	888.45	2941.56	984.99	
66	" 15,	Philadelphia, - - -			72 01	917.85	2972.88	995.48	

VI. SERIES OF 1843, LAKE SUPERIOR, &c.

67	Aug. 21,	Cincinnati, - - - -	39° 06′	84° 22′	70°25′30″	1000.76	2986.98	1000.20 *	
68	" 21,	Cincinnati, - - - -	39 06	84 22	70 25 30	1000.	2986.98	1000.	
69	June 6,	Hudson, Ohio, - - -	41 26	82 27	73 00 00	883.40	3021.50	1012.32	
70	" 12,	Detroit, Michigan, - -	42 25	82 56	73 32	855.63	3018.55	1011.34	
71	" 13,	Ann Arbor, - - - -	42 16	83 39W.	73 12 36	877.86	3039.00	1018.20	
72	" 14,	Ann Arbor, - - - -	42 16	83 39	73 14 46	876.43	3030.40	1018.64	
73	" 15,	Detroit, - - - - -	42 25	82 56	73 32 25	854.89	3017.17	1010.90	
74	" 18,	Mackinaw, - - - -	45 54	84 10	76 38 51	715.87	3100.40	1038.75	
75		Sault St. Marie, - -	46 31	84 32	77 30 15	669.47	3094.10	1036.65	
76	July 2,	Encampment, L.Superior,	46 44	87 43	76 58 19	695.91	3087.10	1034.10	
77	" 8,	Houghton's River, - -	47 28 N.	88 01	77 20 45	671.24	3064.30	1026.62	
78	" 8,	Magnet Inlet, - - -	47 28½	88 01W.	78 45 20	619.14	3175.00	1063.80	
79	" 11,	Magnet Inlet, - - -	"	"	78 43 20	620.80	3183.62	1066.66	
80	" 15,	500 ft. east of Mag. Inlet,	"	"	78 37 30	623.59	3160.70	1059.31	
81	" 11,	Isthmus, - - - - -	"	88 00	78 28	629.88	3150.38	1055.50	
82	" 8,	United States Agency,	"	"	77 13 30	717.13	3243.20	1086.58	1.97029
83	" 13,	Eagle River, - - -	47 27	88 23	77 54 30	648.20	3094.40	1036.72	
84	" 21,	La Pointe, - - - -	46 47	90 58	76 56	704.72	3117.5	1044.50	1.89400
85	" 26,	Ontonagon, - - - -	46 52	89 31	77 13 10	686.17	3101.81	1039.23	
86	" 28,	Isle Royale, - - - -	48 06	88 47	78 07 36	646.40	3141.7	1052.60	1.90808
87	Aug. 4,	Cleveland, Ohio, - -			73 08	880.17	3033.54	1016.34	

* The above quantities refer to "Cincinnati, May 8, 1841," as unity. In the following series the standard assumed is that of Cincinnati, August 21, as unity, both of horizontal and total intensity, as follows.

GEOLOGY OF PORTER'S ISLAND AND COPPER HARBOUR.

The geology of this and the neighbouring regions, has been well treated by Dr. Houghton, the geologist of the state of Michigan, to whose writings we refer the reader for information more general than it is my object, in this article, to present. The rocks of Copper Harbour, and indeed of the whole of Kewenon peninsula, are decidedly metamorphic, showing every degree of change produced by igneous agency, from unchanged sandstone to compact greenstone. The original stratification is, mostly, more or less evident, presenting in the various superimposed layers, an inexplicable variety, some layers bearing evidence of semi-fusion and a correspondent degree of induration and endurance, while others seem scarcely to have been altered, still remaining soft and yielding readily to atmospheric agency, and especially to the assaults of the waves from the lake. Whether these differences have been produced by an unequal distribution of the heat, or by an original difference in the layers of the strata, some being of a nature more suscep-

tible of change by heat, I was unable to determine. At Copper Harbour the strata dip very regularly to the northward, at an angle of about 30°, and consequently they plunge, on one side, under the lake itself; and rising on the other side above the waters form a rocky slope well calculated to receive, lift up, and gradually destroy the mighty waves which the strong north-west wind often throws upon the coast. These two characters, the alternation of soft and hard layers, and their inclination in such manner as to bring those layers alternately to the surface, afford the proper key to the topography of the coast. It is evident that the lake must necessarily act more rapidly on the softer than on the harder strata, and that the waves will, by breaking over, or by a narrow breach through, the barrier formed by a harder stratum, break down and remove a soft stratum interiorly, as it were, and thus form elongated bays with but a narrow inlet. As the action proceeds, the hard stratum itself giving way, at numerous points, will be cut up into numerous islands, situated in a chain, still protecting a bay or harbour within. These islands, too, when seen endwise, present, with great uniformity, the appearance of saw-teeth, rising, as they do, gradually on the slope next to the lake, and dropping abruptly on the side next to the shore. These characters are well exhibited at Copper Harbour and at Agate Harbour, a few miles to the westward of it. Copper Harbour itself seems to have been formed by the removal of a softer stratum of metamorphic sand rock, while Porter's Island is a part of the barrier, formed by the outcropping of a harder layer.

DESCRIPTION OF THE PLATES.

Plate No. 43, is a chart of the United States, on a conical surface, passing, unrolled, through the parallels of twenty-five and fifty degrees of north latitude. I have since had occasion to prefer a chart on a tangent to that on a chord, the difference would have been that the meridians would have been somewhat more distant than they actually are. The object of this chart is to exhibit to the eye the approximate configuration, especially of the isodynamic lines; farther than this I attach no especial importance to them. It appears that they form ellipses more or less concentric; a fact anticipated, and clearly pointed out by Colonel Sabine, in 1838, from very distant surrounding observations made on the Atlantic, Pacific, and at Baffin's Bay. My observations have fixed, more precisely, those lines, have determined the value of the intensity at particular localities, and have shown that the centre, or axis of greatest intensity, is at, or near to, Lake Superior. It will be seen by the results of my researches, engraved in numbers on the chart, how far I have actual authority for the chart lines. So far as they extend beyond the limits of the United States, and into the British possessions, they are projected with nothing more than a general consistency with distant observations. The researches conducted under the government of Great Britain will presently settle that part of the chart, in a most perfect manner. The unit assumed for the expression of the total intensity is that of Cincinnati, which has been called 1000. The line passing through New York was found to have the intensity expressed by 994, and from this proceeding inwardly, towards Lake Superior, lines have been drawn at 1004, 1014, 1024, &c., having a common difference of 10. Upon every line, I have also marked its value according to Baron Humboldt's unit, adopted by Colonel Sabine, in his Report of 1838, which I have designated by the name Sabine, or the initial S.

The point, line, or surface of maximum intensity, is the subject now of no small interest, and my observations, together with Lieutenant Lefroy's, as alluded to in Colonel Sabine's letter, seem to settle the question that it is at or near to Lake Superior; but whether within the limits of the United States, or of British America, is not positively determined. So abrupt and irregular are the magnetic changes, in very small distances in the region of the lake, that a true mean result requires many varied observations. It is like determining the mean level of a very uneven and broken country by taking random elevations; as by descending upon various unknown points in the night, with a balloon, and determining their altitude barometrically, without being able to discriminate whether you are upon a hill or in a valley; a species of surveying evidently requiring a multitude of observations to furnish a correct mean. I have drawn the chart of this part according to the present conditions of knowledge, and leave it open to such modifications as future developments may demand. I have represented an "axis" of total intensity, as suggested by Colonel Sabine's letter, uniting the point of maximum intensity discovered by Lieutenant Lefroy, in the line of his journey, with that discovered by myself in a line intersecting that through which he passed, but extending scarcely beyond it. My desire to return and multiply observations in that region this summer is almost uncontrollable, but my private means will not permit it, and I despair of any assistance from government, or from any other source. While Great Britain is sending out naval expeditions, and encompassing the earth with her magnetical researches, I feel impatient that there is no means by which I can be aided in completing a kind of magnetical reconnoisance of our own country. I do not ask to be paid for it, I merely ask to be helped a little;—I am still willing to make a personal sacrifice.

"The line of equal variation," placed on this chart, is not the result of my own observations, but is copied from a chart by Professor Loomis, published in Silliman's Journal. It is introduced merely to illustrate the popular definitions with which this paper commences. The line of equal dip is also introduced for popular explanation, but it was the result of my own experiments. More lines of equal dip might have been introduced, but I have chosen to designate the dip in numbers, and leave the chart clear of the confusion necessarily arising from the intersection of different systems of lines.

After all, I fear that my readers will suppose that I attach more importance to the chart lines than they are worth. This point will be determined by the support which they derive from the observations; and it will be seen that they represent to some extent rather what is desirable than what has been attained. The southern line, 994, has a number of observations to support it from New York to the Mississippi. The second one, 1004, has scarcely more than two. The third, 1014, has two groups, one in Iowa and the other about Lake Erie. The fourth, 1024, is sustained by one group, only. The fifth, 1034, has only two observations near to it, at Mackinaw and at the Sault St. Marie. The sixth, 1044, is determined by the observations at La Pointe, while the other observations along the line are too low. The axis or maximum line, is sustained by the mean of numerous observations at Copper Harbour, and by one observation on Isle Royale. It may be, too, that the high intensity observed at Copper Harbour will not be sustained by that of the surrounding regions, when it would appear, to speak figuratively, that at Copper Harbour there is an isolated mountain, an outlier of high intensity. Although to make an accu-

rate chart calls for a multitude of observations still to be made, yet it is not useless to excite the inquiry, *is the line traced right, or wrong?* and, at the same time, to point out where observations are needed, the most readily to determine the chart lines. Could the results of the observations made by Major Graham, in the north-east parts of the United States, by Professor Bache, in Pennsylvania, New York, and along the St. Lawrence, and those in the western portions by Professor Loomis, be united, and my own added, the chart would be more extensively determined.

Plate No. 44.—This is copied from Major Sabine's Report. It shows the relative position of the astronomic pole, the pole of dip and of convergence, discovered by Ross, and the pole of maximum intensity, approximately settled by the observations of 1843. These are nearly on the same meridian, and not far from twenty degrees asunder; 85° to 90° west longitude, and 47½°, 70°, and 90°, north latitude. I have also retained Colonel Sabine's lines of 1.6, 1.7, and 1.8, showing that his anticipation of the general configuration of the isodynamic curves has been so far sustained by actual survey. We should naturally suppose that the pole of dip and of convergence would be also the pole of intensity; but research shows it to be otherwise, and it is another amongst numerous instances in which Baconian induction has overthrown dreams not founded on experiment. This interesting fact, that these points are separate, was also pointed out by Colonel Sabine.

Plate No. 45.—This plate is intended to show the situation of Porter's Island, the locality at which I found the greatest intensity. The general chart No. 1, will show the general situation of Copper Harbour, on the extreme northern edge of Kewenon peninsula. The lower figure on the plate shows Copper Harbour on a large scale, with Porter's Island, as part of the barrier between the harbour and the lake, just over the words COPPER HARBOUR.

The upper figure represents Porter's Island on a still larger scale, showing the topography and geology. The right hand part marked, "*bare conglomerate rocks*," is composed of imperfectly stratified brown rocks, rising from the lake at an angle of 30°, and overlapping at the words "conglomerate ends," a sandstone changed by heat into a kind of trap rock. At this junction of the rocks a sudden magnetic change is evident, the dip is suddenly increased by a quantity equal to 1° 3′. The several magnetic stations referred to in the text, are here marked by numbers beginning at the extreme west, 1, 2, 3, 4, &c., to 7, at "Magnet Inlet," and 8 and 9, beyond or east of it. At Magnet Inlet the dip, 78° 45′, and the intensity, 1065, are engraved. Here, in passing from station 6 to 7, about 500 feet, the dip increases more than one degree. At the east end of the island is a section of the rocks of which it is composed, enlarged to twice the scale of the Island itself. East of Copper Harbour is a sketch of a copper vein, the spar, including the ore, being about ten feet wide. At a little island east of Porter's, is marked "Metallic Copper." To prevent mistake, it is proper to note that this island is composed of conglomerate rock on which some small pieces of metallic copper have been found. The topography of this harbour is a type of that of the coast for many miles; the upturned edges of the dipping strata throwing the coast into ridges parallel to the shore, and giving an oblong and parallel form to the inlets, bays, harbours, lakes, and islands. The portion marked "Houghton's Lake," is a distinct lake, communicating with the harbour by a river, having several feet of fall. By the side of this river was another magnetic station, and upon the isthmus to the east, still another.

Plate 46.—On this plate are delineated, by the usual means of ordinates, the curves of the dip and of the corresponding total intensity. The delineation has been made upon paper divided into square millimeters; this unit being selected as the least which is easily distinguished. It will be seen, by inspection, that the horizontal distances represent the progress in latitude or longitude, a millimeter to a mile, and that the ordinates, or perpendicular distances, represent the dip, half a millimeter to a minute. The total intensity is represented in still another line, Cincinnati being 1000, and a millimeter being a unit or a thousandth part of the intensity at Cincinnati. As neither the zero of dip nor of intensity come into the scale, the one will be learned at the margin to the right and left; and, the other, by the actual numerical value placed at some one or more of the points along the line.

The most striking circumstance developed by these lines is, that they have a contour apparently determined by the geology of the region over which the line of observation passes. Thus, the line of dip over the horizontally stratified aqueous rocks of the west, through Kentucky and Ohio, and along the Mississippi, are mostly in a gradual ascent, without inversions, while the same line from Baltimore to New York, over igneous rocks, has remarkable fits of ascent and descent, like the contour of primitive or igneous mountains. The line along Lake Superior is still more remarkable in its undulations, and here too are the strongest evidences of igneous action. The observations require to be extended further before a general theory be deduced; but, so far, they go to show that the general nature of subsequent rocks may be ascertained by the magnetic elements; the instruments serving the purpose of the popular notion of a "divining rod." Another fact conspicuously shown by these lines is, that where the dip takes a sudden and anomalous increase, the total intensity shows a correspondent decrease; and the reverse; as at Bristol, Trenton, and New York; slightly at Lexington, Kentucky, and excessively at Porter's Island. The apparent exception is at Isle Royale, where both curves ascend, but this is only apparent, as Isle Royale is quite out of a line between the other places, being further to the north.

Read September 20, 1844.

Medical College of Ohio, Cincinnati, August 13, 1844.

To the American Philosophical Society:—

Since I had the honour of reading before you my paper on Terrestrial Magnetism, I have completed another series of observations, the result of which is herewith communicated to you, in the fascicle for 1844. The paper is hardly a "readable" one, being mostly a table of results expressed chiefly in numbers. Some remarks, however, on local attractions, and the connexion of magnetism with geology and topography, illustrated by a drawing, will, I hope, be found interesting. At any rate, I venture to

request the society to examine the subject so far as to understand the results at which I think I have arrived. Especially am I anxious that they should examine the double siphon curve which represents the magnetic forces along a line traversing a trappean or other pinnacle, capable of becoming feebly magnetic; or, the proposition may be stated, without reference to a figure, as follows. The intensity which ordinarily has a value along a line of moderate length, not varying beyond certain moderate limits, becomes, at the base of a trappean pinnacle extraordinarily diminished, and, at the top of the same, still more extraordinarily increased. This, it will be seen, was decidedly the case at the Palisades of Fort Lee, at Snake Hill, near Bergen, and at Garret Rock of Patterson, New Jersey. I am aware that before this can be admitted as a general law it must be verified in a greater number of instances, and, to draw attention to the settling of the question by the very legitimate method of multiplied observations, is the object of my addressing to you this note on the subject.

JOHN LOCKE.

SERIES FOR 1844.

Cincinnati, March 21, 1844; Latitude 39° 06′, N.; Longitude 84° 22′, W.

Dip.	No of Needle.	Epoch of commencing Vibrations.	Duration of 500 Vibrations.	Tempe-rature.	Calculated duration at 60°.	Square of the preceding.	Horizontal intensity.	Total intensity, Hor. being 1000.
70° 28′	4	*						
	5	1*h*.39*m*.02*s*.8 P	1351.2	46°5	1352.48	1829202.1504	997.67	
	6	3 01 59 6	1345.6	46 5	1347.02	1814947.8400	997.92	
						Mean,	997.79†	1000.23

Locality and geology as previously described.

Cincinnati, July 4, 1844.

70° 25′	4	9*h*.45*m*.59*s*.2 A	1111.59	76°0	1110.43	1233054.7849		
	5	10 10 59 0	1352.4	76 0	1350.90	1824930.8100		
	6	10 40 44 0	1348.0	78 5	1345.80	1811177.6400	1000.	1000.

The above is assumed as the base of this series of observations. The logarithm of the total intensity, in the terms of the horizontal intensity, 3.4747251.

Wheeling, Virginia, Latitude 40° 08′, N.; Longitude, 80° 47′, W.; March 24, 1844.

72°19′20″	4	3*h*.50*m*.01*s*.6 P	1156.0	52°0	1156.6	1337723.56	922,58‡	
	5	4 20 00 8	1410.0	50 5	1410.95	1990779.9025	916.69	1012.9

Observations made in a ravine above the city. Sandstone and shale, of the coal measures, lying nearly horizontally.

* Some mistake in the observations.

† That at Cincinnati, July 4, 1844, being 1000.

‡ It appears that the needle No. 4 was out of level during almost the whole journey, viz., until June 20, giving an intensity uniformly too high. From a mean of twenty observations a subtractive constant was obtained, the multiplier for which is .00285. Then, 922.58 — 922.58 × .00285 = 919.95, which is still much higher than the indication by No. 5, upon which I rely with so much more confidence that I have excluded the result by No. 4.

Cumberland, Maryland, Latitude 39° 56′, N.; Longitude 78° 47′, W.; March 26, 1844.

Dip.	No. of Needle	Epoch of commencing Vibrations.	Duration of 500 Vibrations.	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal intensity.	Total intensity, Hor. being 1000.
71° 36′	4	3h.56m.01s.6 P	1144.8	69°0	1143.8	1309033.4569	941.95	
	5	4 22 04 4	1395.2	70 0	1394.22	1943849.4084	938.82	
	6	4 50 04 0	1389.2	70 0	1388.65	1928348.8225	939.24	
						Mean,	939.03	996.75

In a ravine. Substratum, sandstone and shale of the coal measures, not horizontal but more or less disturbed by the contiguous up-heaved ridge of the Alleghenies.

Washington, Latitude 38° 53′, N.; Longitude 77° 01′, W.; April 6, 1844; at the Magnetical Observatory, United States Naval Observatory.

71°39′20″	4	1h.22m 02s.0 P	1142.4	53°0	1142.92	1306266.1264	943.05	
	5	1 52 00 0	1391.6	52 0	1392.38	1938722.10644	941.30	
	6	2 26 59 6	1386.0	52 0	1386.97	1923685.7809	941.51	
						Mean,	941.41	1002.58

In the above the reduction of the horizontal intensity by No. 4, by the deduced constant, would give 941 26, quite consistent with the other two needles; still, we have relied on the two Nos. 5 and 6. Geology, drifted gravel and sand, superimposed on gneiss rock in place. It seems that this locality is almost identical with Cincinnati in its total intensity.

Washington, at the old "Depot of Charts and Instruments," near Georgetown, and say one-third of a mile north and a little west of the last station; April 8, 1844.

71°34′48″	4	10h.23m.00s.0 A	1145.60	70°0	1144.86	1310704.4196	939.65	
	5	10 52 01 6	1394.80	72 0	1393.60	1943120.9600	941.99	
	6	11 26 00 0	1389.20	80 0	1388.76	1923103.2976	940.75	
						Mean,	940.72	997.76

Geology, probably identical with that of the preceding.

Washington, at the Capitol Hill, west side of the Capitol, and in a range with the southern end, distant about two hundred feet; April 9, 1844.

71°13′23″	4	7h.36m.02s.4	1138.00	62°0	1138.00	1295044.0000	952.67	
	5	8 04 01 6	1387.60	66 0	1366.97	1923685.7809	948.86	
	6	8 34 05 0	1383.60	71 0	1339.30	1910753.2900	947.88	
						Mean,	948.28	988.22

Washington, Capitol Hill, east side, near the south part of the grounds; April 9, 1844.

71°13′27″	4	6h.35m.02s.0 P	1138.8	63°0	1138.58	1296364.4164	951.16	
							—2.71	
							948.45	987.72

It is presumed, from the situations selected, that they were sufficiently removed from the iron pipes conducting the water through the grounds.

Washington, near the Patent Office, April 10, 1844.

71°14′58″	4	7h.21m.59s.6 A	1141.20	58°	1141.35	1302679.8225	946.55	
	5	7 48 59 6	1390.40	60	1390.40	1933212.1600	943.98	
	6	6 53 01 6	1384.80	56	1385.30	1919056.0900	943.77	
						Mean,	943.88	984.21

In the grounds of the Patent Office, north of its western end.

Washington, between the War Office and the President's house, April 11, 1844.

Dip.	No. of Needle.	Epoch of commencing Vibrations.	Duration of 500 Vibrations	Temperature.	Calculated duration at 60°.	Square of the Preceding.	Horizontal intensity.	Total intensity, Hor. being 1000.
71°20′30″	4	10*h*.48*m*.01*s*.2 P	1141.20	78° 0	1139.87	1299303.6169	949.71	
	5	11 13 00 0	1390.00	79 00	1388.06	1926710.5636	947.16	
	6	11 46 02 4	1384.80	84 00	1381.88	1909592.3344	948.47	
						Mean,	947.81	993.00

This station, approaching to those of the Observatory and Depot, exhibits a correspondent approach in the elements.

Georgetown, a little east of the point at which High Street crosses the first ridge after leaving the city, in an enclosed wood; April 10, 1844.

71°19′00″	4	1*h*.49*m*.59*s*.6 P	1144.8	75°0	1143.80	1308278.44	943.19	
	5	2 14 03 6	1394.00	73 5	1392.60	1939334.76	941.07	
	6	2 45 00 0	1388.80	75 0	1387.00	1923769.00	941.47	
						Mean,	941.27	984.88

Substratum, a light micaceous, ferruginous soil, superimposed on gneiss rock, extremely prone to disintegration, from a loss of its feldspar.

Mount Vernon, Virginia, Latitude 38° 41′; Longitude 77° 07′; April 11, 1844, about seven hundred feet westward from Washington's tomb.

70°55′30″	4	12*h*.43*m*.03*s*.6 P	1126.80	84°0	1125.04	1265715.0016	974.91	
	5	1 13 01 2	1375.20	86 0	1372.70	1884305.2900	968.49	993.30

Probably the eocene tertiary, superimposed on gneiss. The experiments were made in the shadow of the trunk of a pine tree.

Philadelphia, Latitude 39° 57′, N.; Longitude 75° 10′, W.; April 19, 1844. In the yard of the Magnetical Observatory, near Girard College.

71°59′15″	4	9*h*.52*m*.00*s*.	1158.40	51°0	1158.92	1343095.5664	918.07	
	5	10 28 00 4	1412.00	52 5	1412.74	1995438.7600	914.55	
	6	10 59 01 6	1406.40	55	1407.02	1979311.3344	915.55	
						Mean,	915.05	991.84

The above is an unusual result at Philadelphia, the total intensity having been usually between 993 and 995. I am unable to account for this, unless it has been the result of using a chronometer, the rate of which, in various positions, had not been well determined, my own chronometer having been broken.

Princeton, New Jersey, Latitude 40° 22, N.; Longitude 74° 39′, W.; May 23, 1844; at the usual locality, shown to me by Professor Henry.

72°40′15″	4	4*h*.05*m*.03*s*.2 P	1182.8	77°	1181.5	1395942.25	883.30	993.96

Shale stratified nearly horizontally. This locality is in the open field.

Princeton, second station, Potts's Woods, May 23, 1844.

72°41′25″	5	5*h*.42*m*.01*s*.6 P	1438.4	72°0	1437.2	2065543.84	883.51	994.82

At this station the instruments were more perfectly sheltered from the sun. Geology same as above. Materials believed to be not magnetic.

Princeton, second station, same as above, May 24, 1844.

Dip.	No of Needle.	Epoch of commencing Vibrations.	Duration of 500 Vibrations.	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal intensity.	Total intensity, that at Cincinnati being 1000.
72°41′16″	4	6h.47m.58s.4 A	1180.8	57°	1181.03	1394761.0000	884.06	
	5	7 20 04 4	1439.6	59	1439.70	2072736.0600	880.44	
	6	7 54 04 8	1436.4	61 5	1435.93	2061435.4929	878.60	
						Mean,	879.52	990.53

The above, by reducing the result of No. 4 by the constant .00285, makes 884.06. — 2.52 = 881.51, and including this with the results of Nos. 5 and 6, as above, gives as a mean for total intensity 991.40, instead of 990.53, as above.

Princeton, third station, Rocky Hill, May 24, 1843.

72° 35′	4	11h.38m.02s.8 A	1178.0	78°	1176.7	1384622.89	890.53	997.32

This station is more than a mile from the town, and is at a ridge of trap, rising gradually from the shale below.

New Brunswick, New Jersey, Latitude 40° 30′, N.; Longitude 74° 25′, W.; May 4, 1844; a quarter of a mile south of the city, in a little ravine.

72°43′13″	4	3h.34m.02s. P	1183.2	77°0	1181.9	1396887.61	882.71	
	5	4 06 03 6	1440.4	77 5	1438.64	2069685.0496	881.69	
	6	4 38 00 0	1435.6	75 5	1433.64	2055323.6496	881.21	
						Mean,	881.45	994.64

I considered the above an unexceptionable locality, and that the elements represented the mean of the neighbourhood. The rock is a shale not far below the surface.

Columbia College, New York City, Latitude 40° 42′, N.; Longitude 74° 01′, W.; April 27, 1844.

72°42′38″	4	12h.39m.01s.2 P	1180.8	55°0	1181.18	1395186.1924	883.79	
	5	1 06 04 4	1438.4	53 5	1439.05	2070864.9025	881.24	
	6	1 37 04 0	1431.6	50 0	1432.86	2053087.7796	882.12	
						Mean,	881.68	994.35

Diluvial sand, of great depth, superimposed on gneiss.

Asylum for the Insane, near Harlaem, eight miles north of New York; April 26, 1844.

72°41′40″	4	12h.52m.51s.6 P	1182.8	78°5	1181.40	1395705.76	883.46	
	5	1 23 09 2	1441.2	79 0	1439.30	2071584.49	880.93	
	6	1 52 02 0	1436.6	82 0	1433.62	2055266.3044	881.23	
						Mean,	881.08	992.40

Prismatic gneiss rock, near the surface.

Newark, New Jersey, Latitude 40° 43′, N.; Longitude 74° 10′, W.; April 29, 1844; at Mrs. Morris's Garden, in Washington place.

72°50′15″	4	8h.21m.00s.8	1186.8	61°5	1186.80	1408494.24	875.44	
	5	8 52 00 0	1444.4	61 5	1444.40	2086291.360	874.72	
	6	9 25 10 0	1440.4	63 0	1440.00	2073600.0	873.44	
						Mean,	874.08	992.40

Deep alluvium, superimposed on new red sandstone.

Newark, New Jersey, Ward's Woods, on what is called "The Neck;" April 29, 1844.

Dip.	No of Needle.	Epoch of commencing Vibrations.	Duration of 500 Vibrations	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal Intensity	Total Intensity, that at Cincinnati being 1000.
72°46′20″	4	3*h*.49*m*.04*s*.4 P	1185.6	80°	1184.06	1401998.0836	879.49	
	5	4 18 04 4	1445.2	77 5	1443.37	2083226.9569	876.01	
	6	4 49 07 0	1438.58	74 5	1436.10	2062383.2100	878.19	
						Mean,	877.10	992.61

Deep marshy soil, with probably sandstone beneath, but at great depth.

Poughkeepsie, New York, Latitude 41° 41′, N.; Longitude 73° 55′, W.; June 13, 1844.

73°57′45″	4	1*h*.21*m*.01*s*.2	1228.8	85°0	1226.8	1505038.24	819.87	
	5	1 53 04 8	1495.2	84 0	1492.3	2226959.2900	819.47	
	6	2 19 00 4	1487.6	84 0	1484.5	2203740.25	819.22	
						Mean,	820.85	995.89

Slate, very much distorted and inclined.

Poughkeepsie, west side of the Hudson, opposite the town; June 13, 1844.

74°12′20″	5	5*h*.05*m*.01*s*.6 P	1492.4	63°0	1492.10	2226362.41	819.70	1009.4

In a ravine, and near to the highest part of the rocks, which are highly inclined and consist of thick beds of sandstone and slate.

Greenbush, opposite Albany, about half a mile east of the village, June 14, 1844; Latitude 43° 39′, N.; Longitude 73° 44′, W.

74°40′36″	4	11*h*.19*m*.01*s*.2 A	1252.00	70°1	1251.08	1565201.1664	781.40	
	5	10 42 02 4	1524.80	70	1523.73	2321753.1129	786.01	
	6	12 00 00 8 P	1518.00	70	1516.66	2300257.5556	787.38	
						Mean,	786.69	997.79

Shale, but covered deep by diluvium.

Albany, New York, Arbor Hill, three-quarters of a mile north-east of the State House; Latitude 42° 39′, N.; Longitude 73° 43′, W.; June 14, 1844.

74°40′10″	4	4*h*.58*m*.03*s*.2 P	1250.80	75°	1249.58	1561450.1764	790.27	
	5	5 28 02 8	1524.00	75	1522.40	2317701.7600	787.38	
	6	6 00 00 0	1518.40	73	1516.67	2300287.8889	787.83	
						Mean,	787.60	998.48

Deep diluvium, of clay and sand.

Utica, New York, Latitude 43° 07′, N.; Longitude 75° 13′, W.; June 16, 1844.

74°48′49″	4	3*h*.57*m*.02*s*.8 P	1251.02	78°0	1249.76	1561900.0576	789.46	
	5	4 39 04 8	1523.60	76 0	1521.09	2316179.6100	787.90	
	6	5 15 01 6	1518.80	76 0	1516.66	2300257.5556	787.38	
						Mean,	787.64	1007.80

Deep alluvium, superimposed on slate. (?) In a meadow half of a mile from the town, not magnetic.

Rochester, New York, Latitude 43° 08′, N.; Longitude 77° 51′, W.; June 17, 1844.

74°38′48″	4	5*h*.02*m*.03*s*.2 P	1246.00	77°	1244.62	1549078.9444	795.79	
	5	6 28 00 0	1516.80	76	1515.11	2295558.3121	794.98	
	6	6 55 02 8	1510.40	65	1509.74	2279314.8676	794.61	
						Mean,	794.79	1006.14

About one and a half miles north, thirty east, from town, in a wood near four very large chestnut trees. Horizontally stratified limestone, not magnetic.

Lockport, Latitude 43° 11′, N.; Longitude 78° 46′, W.; June 18, 1844.

Dip.	No. of Needle.	Epoch of commencing Vibrations.	Duration of 500 Vibrations	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal Intensity.	Total Intensity, that at Cincinnati being 1000.
74°44′12″	4	10*h*.12*m*.01*s*.6 A	1248.00	79°0	1246.46	1553662.5316	993.60	
	5	10 50 04 8	1520.80	83 0	1518.35	2305386.7225	991.55	
	6	11 25 00 0	1516.00	85 0	1512.58	2287898.2564	991.11	
						Mean,	991.33	1007.32

One mile south-east of town, in a wood-land. Horizontal limestone and shale.

Buffalo, June 23, Latitude 42° 53′, N.; Longitude 78° 55′ W.

74°36′30″	4	5*h*.44*m*.01*s*.6 A	1240.50	55°	1240.90	1539832.81	807.72	
							—2.30	
							805.42	1017.01

In a low marshy ground, about thirty rods east of the American Hotel. Lacustrine formation, underlaid by limestone.

Toronto, Upper Canada, Latitude 43° 33′, N.; Longitude 79° 20′, W.; June 19, 1844.

75°12′30″	4	6*h*.26*m*.03*s*.2 P	1258.00	74°	1256.86	1579697.0596	780.56	
	6	6 54 02 0	1526.00	72	1524.92	2325381.0064	—2.62	
							778.94	
							778.87	
						Mean,	778.90	1022.58

These experiments were made in a wood, about one and a half miles east of the Magnetical Observatory. Lacustrine clay and gravel, similar to that of the neighbourhood. I broke the filament of needle No. 5. It will be seen above that No. 4. still reads too high, and its indications are not included in the result. But in the following observations, that needle having been re-levelled, its indications became quite consistent.

Toronto, Upper Canada, June 20, 1844; Magnetical Observatory.

75°13′22″	4	10*h*.43*m*.05*s*.2 A	1259.2	71°	1258.30	1583318.8900	778.77	
	5	11 24 04	1532.4	75	1530.80	2343348.6400	778.77	
	6	12 00 01 2	1528.0	76	1526.00	2328676.0000	777.77	
						Mean,	778.44	1022.95

These observations were made in the little shed where the dip is usually taken. Geology, the same as at the last locality. The only objection to the geology, for a magnetic station, is, that the soil contains rather an abundance of black magnetic sand. In obtaining the above dip, I repeated the observations several times, generally averaging a higher dip, even as high as 17′, but always with some obscurities or inconsistencies, until both needles concurred in the above result; which was, at the same time, consistent with the observations made yesterday, and with a mean of the results of the observatory.

Ashtabula, Ohio, Latitude 41° 52′, N.; Longitude 80° 52′, W.; June 24, 1844.

73°25′03″	4	10*h*.06*m*.00*s*.8 A	1198.8	78°0	1197.40	1433766.76	859.94	
	5	10 34 04 0	1458.8	77 5	1457.06	2123023.8436	860.37	
	6	11 08 24 0	1453.2	79 0	1450.90	2105110.8100	859.59	
						Mean,	859.97	1033.55

Clear, wind north-west. Geology, clay and sand, of the lacustrine formation, superimposed, it is presumed, on the sandstone and shale of the coal formation. Locality, close to the lake, and about twelve hundred feet east of the pier or ship-landing.

Warren, Ohio, Latitude 41° 16′, N.; Longitude 80° 55′, W.; June 25, 1844.

Dip.	No of Needle.	Epoch of commencing Vibrations.	Duration of 500 Vibrations.	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal Intensity.	Total intensity, that at Cincinnati being 1000.
72°55′52″	4	8*h*.53*m*.02*s*.8 A	1184.80	77°5	1183.47	1400601.2409	880.35	
	5	9 22 00 8	1440.70	81 50	1438.59	206951.11881	881.81	
	6	9 56 00 0	1437.60	82 00	1434.84	2058765.8256	879.74	
						Mean,	880.63	1005.60

In a wood, and a little west of the bridge. Alluvium, superimposed on the shale of the coal formation.

Wellsville, Ohio River, Latitude 40° 38′, N.; Longitude 80° 44′, W.; June 26, 1844.

72°35′20″	4	8*h*.16*m*.59*s*.6 A	1196.4	83°0	1194.60	1427069.16	Erroneous.	
	5	9 44 00 0	1432.4	85 0	1429.90	2044614.01	892.55	
	6	10 10 00 4	1427.2	85 0	1424.33	2028715.9489	892.77	
						Mean,	892.66	999.91

On the deep alluvium of the Ohio river, in a dark, shady wood. Surrounding hills, shale and coal.

The following observations were intended expressly to show the effects of local attractions, especially those occasioned by pinnacles of trap rocks.

Snake Hill, near the top, April 30, 1844; Latitude 40° 44′, N.; Longitude 74° 08′, W.

73°12′26″	4	12*h*.47*m*.03*s*.	1194.8	75°	1193.07	1424919.69	865.35	
	6	2 09 05 2	1450.0	78	1447.70	2095835.29	864.18	1002.72

Snake Hill is an outlier of trap about seven miles westward from New York, rising abruptly from the salt marsh which nearly surrounds it. Height, two to three hundred feet. It is a prominent object, and was one of the stations in the coast survey. The local effects are sufficiently apparent. The dip, in unexceptionable situations near, would have been about 72° 45′, and the intensity 993 or 4.

Snake Hill, west side, close to the bottom of the perpendicular rock; April 30, 1844.

72°36′20″	4	4*h*.33*m*.01*s*.2	1183.2	81°0	1181.55	1396060.4025	883.24	
							—2.52	
							880.72	987.06

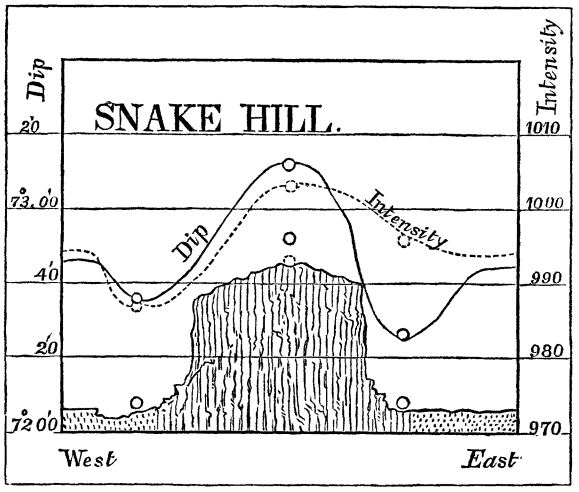
Now if we suppose the vertical trappean hill to be a magnet by terrestrial induction, the upper end must possess an intensity higher than is due to the locality, while the lower end, or bottom of the hill, must exhibit a magnetic force below the same point. In the present case, the mean of the two, the one at the top and the other at the bottom of the hill, viz., 994.88, tallies well with the force or intensity indicated at localities in the neighbourhood, where there is no cause of local disturbance, as at Columbia College, 994.35, or at Princeton, 994.82.

Snake Hill, south-east side, April 30, 1844.

72°27′22″	4	5*h*.50*m*.00*s*.8 P	1172.0	65°0	1171.60	1372446.56	898.43	
							—2.56	
							895.87	996.19

This observation was made on the level of the marsh, and a few rods distant from even the talus, or rocks tumbled from the precipice.

The following diagram shows the curves of dip and intensity in traversing Snake Hill from west to east, as indicated by the above results, and by experiments at neighbouring localities.



Fort Lee, about nine miles north of New York, on the west side of the Hudson, May 2, 1844.

Dip.	No of Needle.	Epoch of commencing Vibrations.	Duration of 500 Vibrations.	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal intensity.	Total intensity, that at Cincinnati being 1000.
72° 28′	4	4*h*.34*m*.02*s*.4 P	1182.2	66°5	1181.7	1396414.89	883.02	982.43

Fort Lee was situated on a promontory which forms the southern termination of the palisades. This promontory has the Hudson river on the east side of it, a ravine and rivulet on the west, and a valley, or recess on the south, in which is situated the village called "Fort Lee."

The palisades are of trap rock, somewhat basaltic or columnar in structure, but presenting rather vertical plates than polygonal columns. Beneath this basalt, at Fort Lee, is a bed of sandstone and shale, lying in a very slight inclination. The valley of the village exhibits a deep deposite of sand and gravel, apparently not magnetic. The station of "the orchard" was of this kind. The above, or station No. 1, was on the ridge of the palisades, about one-third of a mile north of, or above the promontory. The rocks were of trap, scarcely covered with soil, and supporting dwarf cedars and pines.

Fort Lee, Station No. 2, May 3, 1844.

Near the lower end of the promontory, and at the verge overlooking the precipitous descent to the Hudson. With the dipping compass standing on the rocks, the dip read 73° 07′; but when raised up, say three and a half feet on the stand, it read as in the margin below.

72°47′00″ | 4 | 6*h*.12*m*.03*s*.6 A | 1186.4 | 65°0 | 1186.02 | 1406596.0000 | 878.00 | 994.26

Rocks naked, and consisting of massive vertical plates.

Fort Lee, Station No. 3, about forty feet south of No. 2, and on the immediate southern verge of the precipice; May 3, 1844.

72° 51′ | 4 | 6*h*.56*m*.02*s*.4 A | 1167.6 | 70° | 1166.85 | 1361538.9225 | 905.63 | 1029.82

Fort Lee, Station No. 4, about forty feet from each of the other stations, 2 and 3, westward, forming with them an equilateral triangle.

Dip.	No. of Needle.	Epoch of commencing Vibrations.	Duration of 500 Vibrations.	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal Intensity.	Total intensity, that at Cincinnati being 1000.
	4	10*h*.11*m*.02*s*.4 A	1175.2	81°5	1173.6	1377336.96	895.24	

The dip was not taken at this station, but it appears the horizontal intensity was nearly the same as at No. 3.

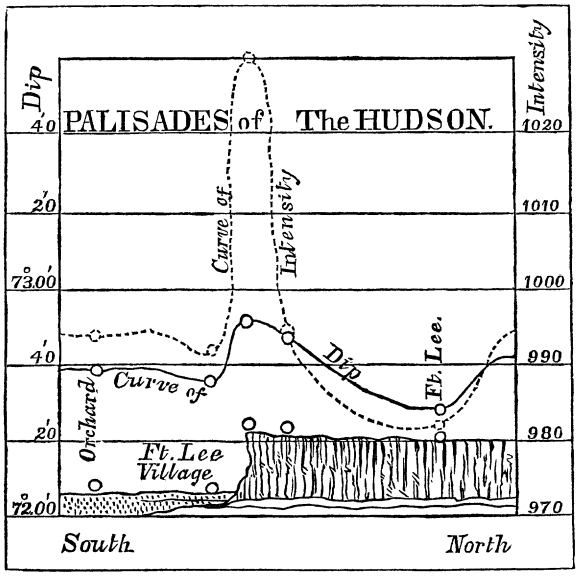
Fort Lee, Station No. 5, at the foot of the promontory, and on the brink of the river, where the sandstone emerges from beneath the trap rock of the Palisades; May 3, 1844.

72° 38′	4	12*h*.10*m*.02*s*.4	1184.4	82°0	1182.67	1398708.3289	881.59	992.24

Fort Lee, Station No. 6, in an orchard, occupying the centre of the recess in which the village has been built. Here the trap rock is wanting, and a deep stratum of drifted sand rests on the subjacent sandstone.

72°39′15″	4	1*h*.57*m*.01*s*.6	1182.4	80°	1180.86	139443033.96	884.27	994.13

The following diagram shows the curves of dip and intensity on traversing the lower precipitous termination of the Palisades from south to north.



Patterson, New Jersey, Latitude 40° 56′, N ; Longitude 74° 10′, W.; June 9, 1844

75°00′30″	4	6*h*.00*m*.01*s*.6 P	1268.00	75°	1260.70	1604680.8976	768.41	995.17

The above result was obtained on Garret Rock, which consists of columnar trap rock, say one hundred and fifty feet high, superimposed on sandstone, nearly horizontally stratified. The station was on the terraced top of the rock, about one hundred feet south of its precipitous northern termination.

Patterson, at the top of the hill of which Garret Rock is a part; June 10, 1844.

73° 55′ 54″	4	Some doubt with regard to the experiment. The probability is, that the quantities were 830.21 and 1005.46. This station was about five hundred yards southwardly from Garret Rock.

Patterson, at the bottom of Garret Rock, and near to the Morris Canal; June 10, 1844.

Dip.	No. of Needle.	Epoch of commencing Vibrations.	Duration of 500 Vibrations.	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal intensity.	Total intensity, that at Cincinnati being 1000.
72°17′24″	4	1*h*.13*m*.00*s*.8 P	1171.60	82°00	1169.92	1368712.8064	900.88	992.64

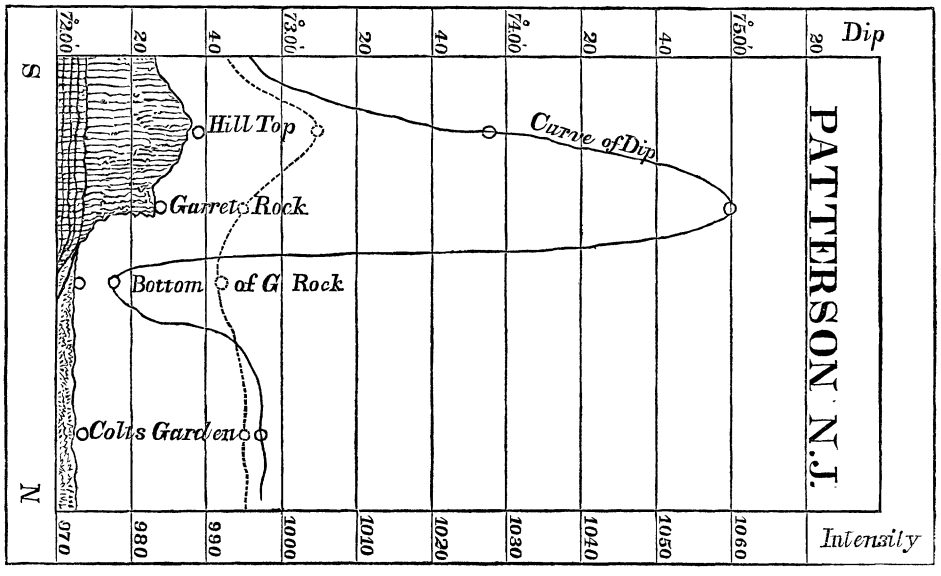
Substratum, sandstone, just below its junction with the superimposed trap rock. The trap of this vicinity is compact, and of a dark colour, entirely destitute of that granular feldspathic structure so apparent in that of Bergen hill.

Patterson, at Mr. R. Colt's Garden, nearly in the centre of the valley in which the town stands.

72°58′06″	4	3*h*.21*m*.03*s*.6 P	1192.0	77°	1190.7	1417766.49	869.71	995.72

This locality, similar to the "orchard," at Fort Lee, may be considered, probably, free from any immediate local attractions, as it is upon a deep substratum of silicious sand, and that again superimposed on sandstone, with no appearance of trappean rocks within half a mile. The distance from Garret Rock is about three-fourths of a mile, in a course a little east of north.

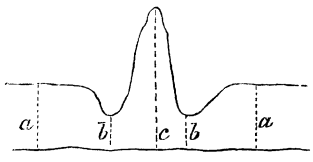
The following diagram shows the curves of dip and intensity in traversing Patterson and Garret Rock from north to south.



REMARKS ON LOCAL ATTRACTIONS.

In the three localities above-named, Snake Hill, Fort Lee, and Patterson, the geology and topography are similar, presenting trappean elevations of moderate height, but having mural or precipitous sides. In the two latter, the trappean mass is superimposed on sandstone, and probably in the first also, but at a depth as yet unexplored. In all of these localities the magnetical elements exhibit the same general phenomena, viz., at the base of the precipice both the dip and the intensity are diminished, but, at the summit,

they are often increased excessively above the mean of the surrounding country, as the dip at Garret Rock, 75° 01′, while the mean dip of the neighbourhood is not over 72° 58′. If we exhibit the dip and intensity, as has been done in a previous paper, by ordinates, on a line passing through the several stations, the curve passing through the superior ends of those ordinates will be of the general form of a double syphon, as shown in the annexed figure, in which the ordinates *a a* represent, say the total intensity of the surrounding country, at unexceptionable localities; *b b* the same at the base of trappean pinnacles, and *c* the same on the pinnacle itself. See the preceding wood-cuts of Snake Hill, Fort Lee, and Patterson, which, as it regards the ordinates, are drawn truly, from actual observations; the horizontal distances and proportional heights in the topographical sketches below the curves, are only generally correct, being drawn without a topographical survey, or a scale of heights and distances. Every magnetician will say, that these phenomena indicate that the trappean pinnacles become magnets by terrestrial induction, diminishing that of the earth at their base, which will be the lower, or north pole, and increasing it at their summits, which will be their upper or south pole. That the dip should be uniformly increased at their summits, must depend on a tendency of the magnetic axis to coincide with the axis of form, which may be considered vertical. Why the dip should be diminished at the base is not so apparent.



There has been some dispute whether the magnetical elements are affected by the altitude of the station. It is most probably the case that they are not affected by mere altitude, as by a balloon, but they may or may not be affected by pinnacles of mountain masses, according to the nature of the materials of which they are composed. My experiments are, so far, a mere step in a long series of labours which are indicated in the research, with regard to local attractions. The immense multiplication of experiments necessary to determine the general laws on the subject is, on the one hand, exciting, as presenting a most interesting field for enterprising research; while, on the other, it is discouraging, especially to a private experimenter, without patronage, and scarcely encouraged by the kind approbation of those amongst whom he is labouring. Not unfrequently he is compelled to suffer all of the distress which neglect, depression, and despondency can inflict. The importance of this kind of investigation is very apparent both in relation to science and to the business of navigation and surveying; for the declination, or variation, is often more affected than even the dip. At Fort Lee the declination changes four degrees in the distance of forty feet; and, at Patterson, on the mountain of Garret Rock, an intelligent surveyor informed me of a change of variation amounting to 32°, in the distance of a few rods. In the midst of disheartening sensations, it was no small encouragement to receive, as an evidence of sympathetic approbation, from a foreign country, the following announcement by Colonel Sabine:—

"*Woolwich, (England,) April* 2, 1844.

"Dear Sir,—

"I am authorized, by the British Association, to offer you the loan of one of Weber's last improved, transportable magnetometers, if you think it will be useful to you. It is described in Taylor's Scientific Memoirs, vol. ii., Article 8. It determines absolute

declinations, and absolute horizontal intensities, and the variations of both. It will consequently, enable you to make the term observations of declination and horizontal intensity at Cincinnati; as well as to make the absolute determinations which you wish. If you think it will answer your purposes, pray acquaint me how it shall be sent, and where addressed. It is quite ready. Of course, you will understand that you will be free to publish your observations with it wherever you think best,—precisely as if the instrument were your own.

"Believe me, my dear sir, with much respect,

"Very sincerely yours,

"EDWARD SABINE."

Colonel Sabine and the British Association will please accept, through this source, my most cordial acknowledgments both for the honour and favour which they have conferred upon me, and especially for the annexed generous and liberal conditions.

GENERAL SUMMARY.—VII. SERIES, 1844, CINCINNATI TO TORONTO, &c.

No.	Date.	Place.	Latitude.	Longitude.	Dip.	Horizontal Intensity.	Total intensity Hor. being 1000.	
88	March 21,	Cincinnati, - - - -	39° 06′	84° 22′	70°28′	997.79	1000.23	That on July 4, 1844, being 1000.
89	July 4,	Cincinnati, - - - -	"	"	70 25	1000.00	1000.00	
90	March 24,	Wheeling, Virginia, -	40 08	80 47	72 19 20″	916.69	1012.90	
91	" 26,	Cumberland, Maryland,			71 36 00	939.03	996.75	
92	April 6,	Washington, - - -	38 53	77 01	71 39 20	941.41	1002.58	At the Magnetical Observatory.
93	" 8,	" "	"	"	71 34 48	940.72	997.76	At old Depot, near Georgetown.
94	" 9,	" "			71 13 23	948.28	988.22	West side of the Capitol.
95	" 9,	" "			71 13 27	948.45	987.72	East side of the Capitol.
96	" 10,	" "			71 14 58	943.88	984.21	Near the Patent Office.
97	" 11,	" "			71 20 30	947.81	993.00	Near the War Office.
98	" 10,	Georgetown, - - -	38 53	77 03	71 19 00	941.27	984.88	
99	" 11,	Mount Vernon, - - -	38 41	77 07	70 55 30	968.49	993.30	Near Washington's tomb.
100	" 19,	Philadelphia, - - -	39 57	75 10	71 59 15	915.05	991.84	
101	May 23,	Princeton, New Jersey,	40 22	74 39	72 40 15	883.30	993.96	Usual station.
102	" 23,	" "			72 41 25	883.51	994.82	Potts's Woods.
103	" 24,	" "	40 22	74 39	72 41 15	879.52	990.53	" "
104	" 24,	" "	40 23	74 39	72 35 00	890.53	997.32	Rocky hill. Trappean.
105	" 24,	New Brunswick, - -	40 30	74 25	72 43 13	881.45	994.64	
106	April 27,	Columbia College, - -	40 42	74 01	72 42 38	881.68	994.35	
107	" 26,	Harlaem, - - - - -	40 49	74 01	72 41 40	881.08	992.40	
108	" 29,	Newark, New Jersey,	40 43	74 10	72 50 15	874.08	992.40	"Washington Place."
109	" 29,	" "	40 43	74 09	72 46 20	877.10	992.61	On the "Neck."
110	June 13,	Poughkeepsie, N. Y., -	41 41	73 55	73 57 45	820.85	995.89	
111	" 13,	Opposite Poughkeepsie,	41 41	73 56	74 12 20	819.70	1009.40	
112	" 14,	Greenbush, New York,	43 39	73 44	74 43 06	786.69	997.79	
113	" 14,	Albany, New York, -	42 39	73 45	74 40 10	787.60	998.48	
114	" 16,	Utica, New York, - -	43 07	75 13	74 48 49	787.64	1007.80	
115	" 17,	Rochester, New York,	43 08	77 51	74 38 48	794.79	1006.14	
116	" 18,	Lockport, New York, -	43 11	78 46	74 44 12	991.33	1007.32	
117	" 23,	Buffalo, New York, -	42 53	78 55	74 36 30	805.42	1017.01	
118	" 19,	Toronto, Upper Canada,	43 33	79 19	75 12 30	778.90	1022.00	Woods 1½ miles E. of Observat'y.
119	" 20,	" "	"	79 20	75 13 22	778.44	1022.95	Observatory.
120	" 24,	Ashtabula, Ohio, - -	41 52	80 52	73 25 03	859.97	1033.55	Close to the lake.
121	" 25,	Warren, - - - - -	41 16	80 55	72 55 52	880.63	1005.60	
122	" 26,	Wellsville, - - - -	40 38	80 44	72 35 20	892.66	999.91	Ohio river.

THE FOLLOWING OBSERVATIONS WERE MADE EXPRESSLY TO DETERMINE SOME OF THE LAWS OF LOCAL ATTRACTION:—

123	April 30,	Snake Hill, - - - -	40° 43′	74° 06′	73°12′26″	864.18	1002.72	Top of the hill. Trappean.
124	" "	" "			72 36 20	880.72	987.06	Bottom, west side.
125	" "	" "			72 27 22	895.87	996.19	Bottom, east side.
126	May 2,	Fort Lee, New York, -	40 51	74 01	72 28 00	883.02	982.43	North part of Hill, station 1.
127	" 3,	" "			72 47 00	878.00	994.26	South promontory, top, 2.
128	" "	" "			72 51 00	905.63	1029.82	Top, extreme verge, 3.
129	" "	" "			Not taken.	895.24		Station 4.
130	" "	" "			72 38 00	881.59	992.24	Bottom of hill,& brink of Hudson.
131	" "	" "			72 39 15	884.27	994.13	In a sandy plain, ½ mile from hill.
132	June 9,	Patterson, New Jersey,	40 56	74 10	75 00 30	768.41	995.17	Top of Garret Rock. Trap.
133	" 10,	" "			73 55 54	830.21	1005.46	Top of trap hill.
134	" "	" "			72 17 24	900.88	992.64	Bottom of hill of trap.
135	" "	" "			72 58	869.71	995.72	In a sandy area—no trap.

ERRATA IN THE PRECEDING PAPER.

Page 286, last line, for "recorded," read *reckoned.*

" 291, eighth line from the bottom, for "bluff or cliff limestone," read *bluff of cliff limestone.*

" 293, about the middle of the page, for "chest," read *chert.*

" 294, in "23. Dayton, Ohio," seventh column of the table, the decimal point is one place too far to the right, thus: for "9511," read 951.1, and so down the column: and in the eighth column of the same table, for "298.71," read 2987.1.

" 307, in the fourth column of table 78, for "138.0," read 1380.

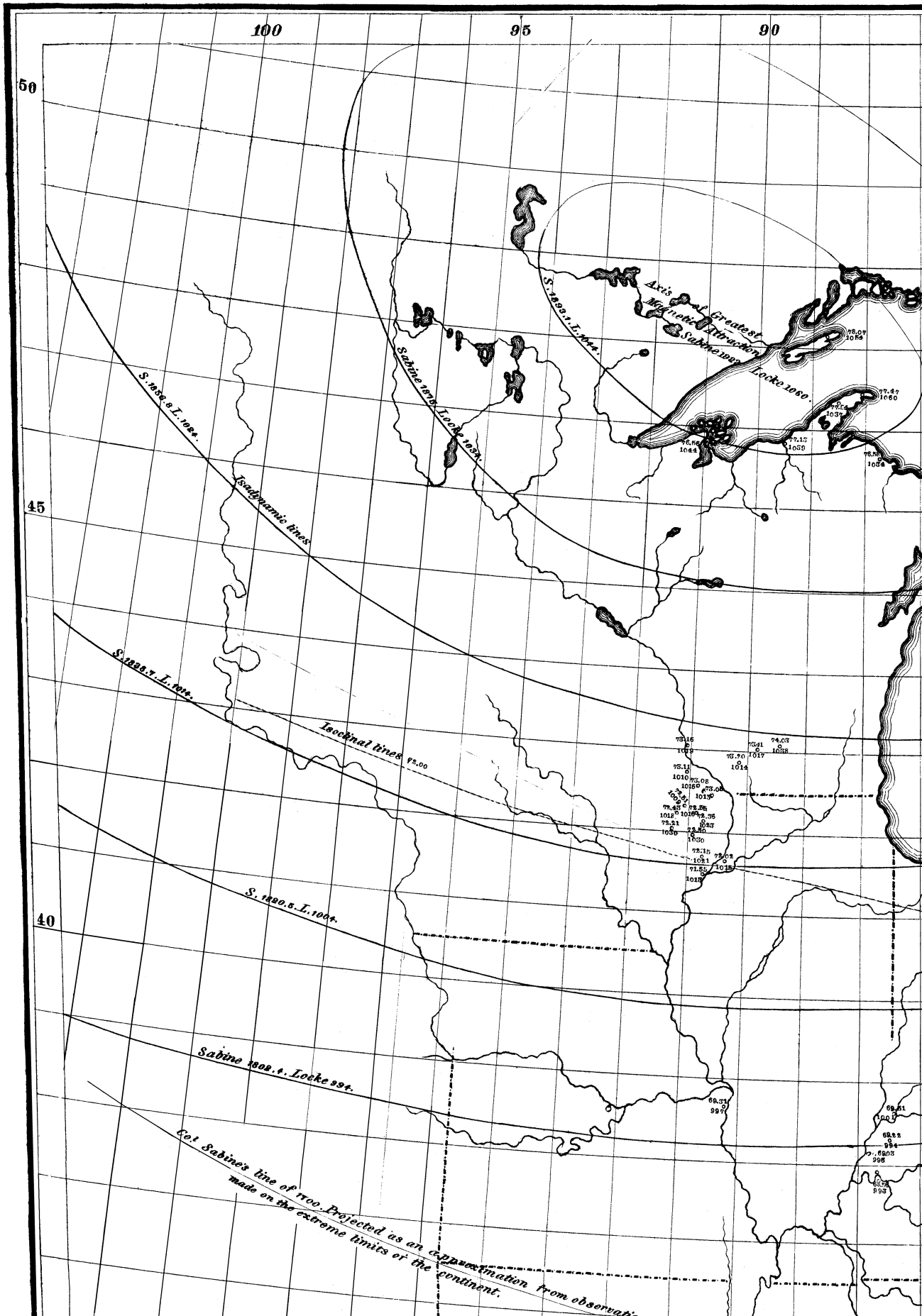
" 309, twenty-second line from top, for "temperature," read *intensity.*

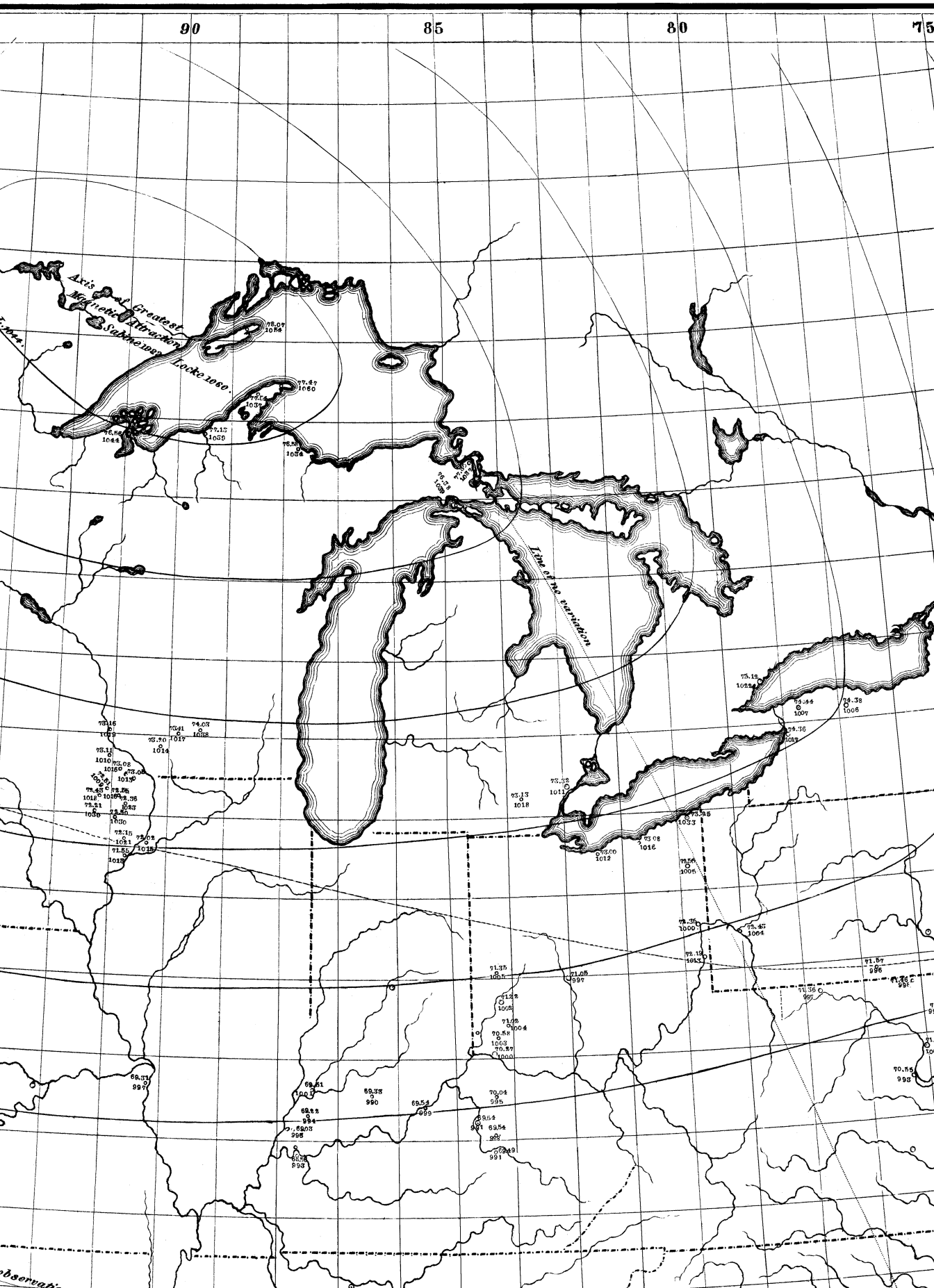
" 309, table at bottom of the page, heading of 9th column, for "horizontal intensity," read *Total intensity that at Cincinnati being* 1000.

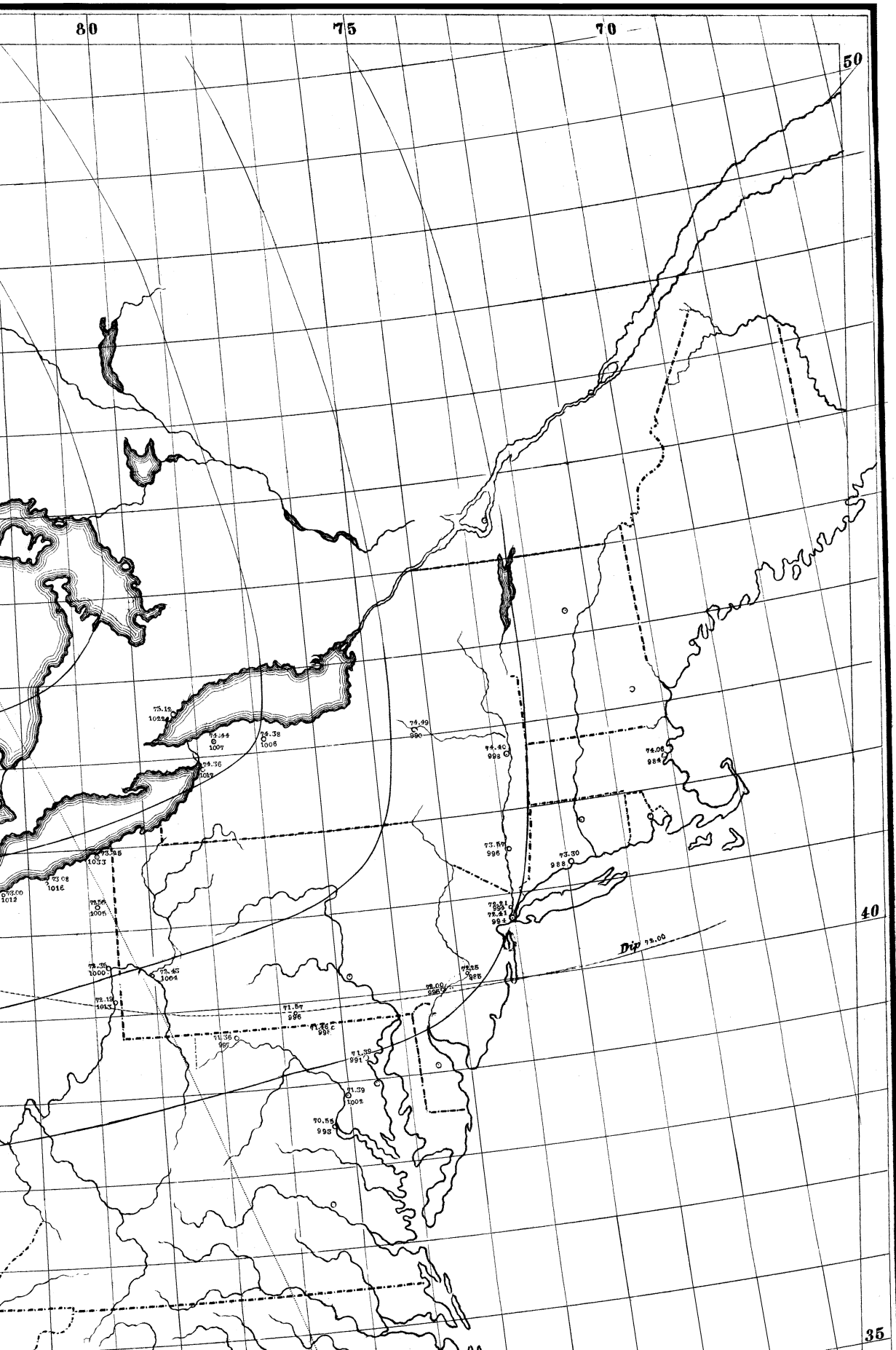
" 311, fifteenth line from bottom, for "as follows," read *as above.*

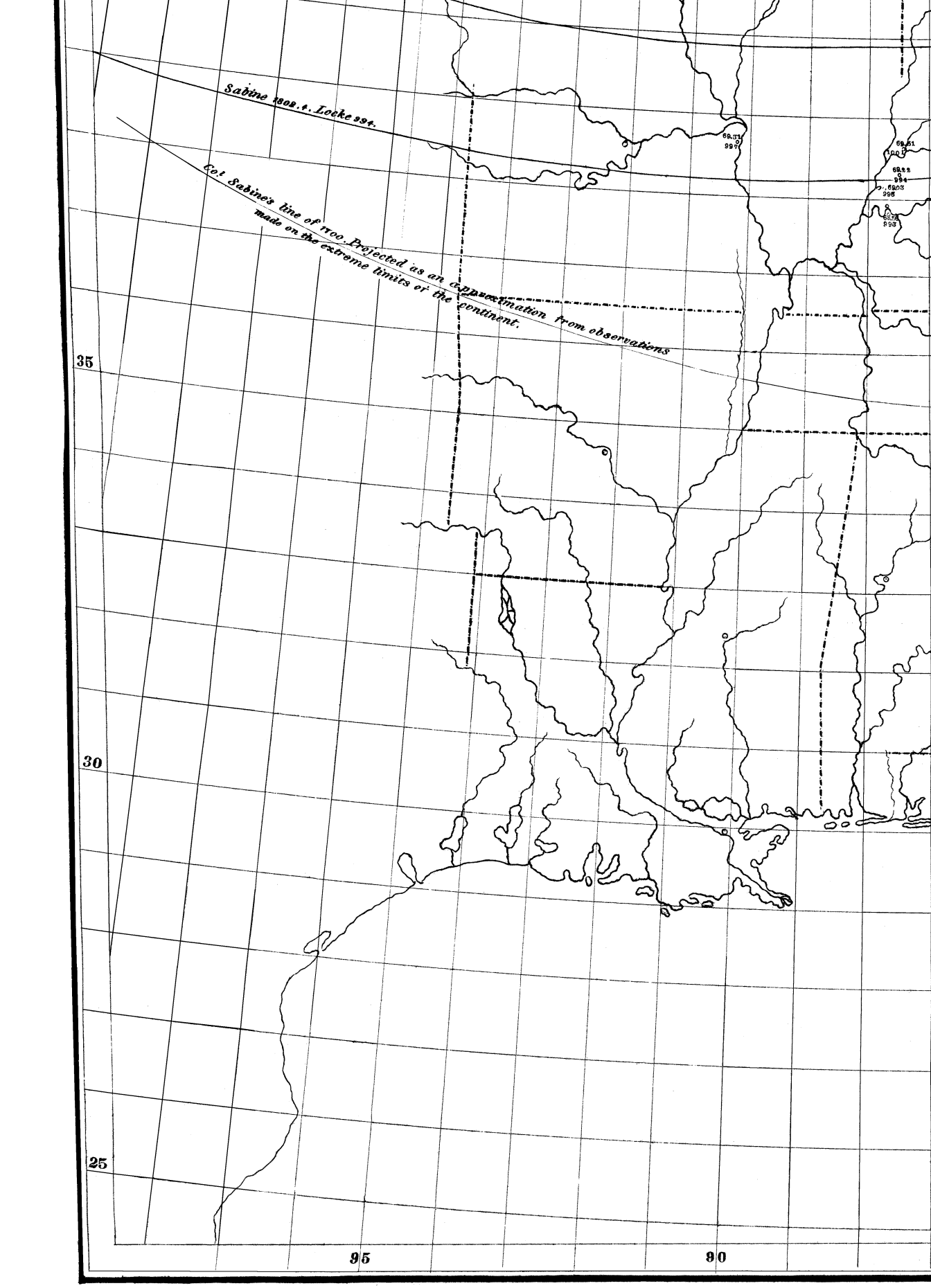
" 315, twenty-second line from top, for "subsequent," read *subjacent.*

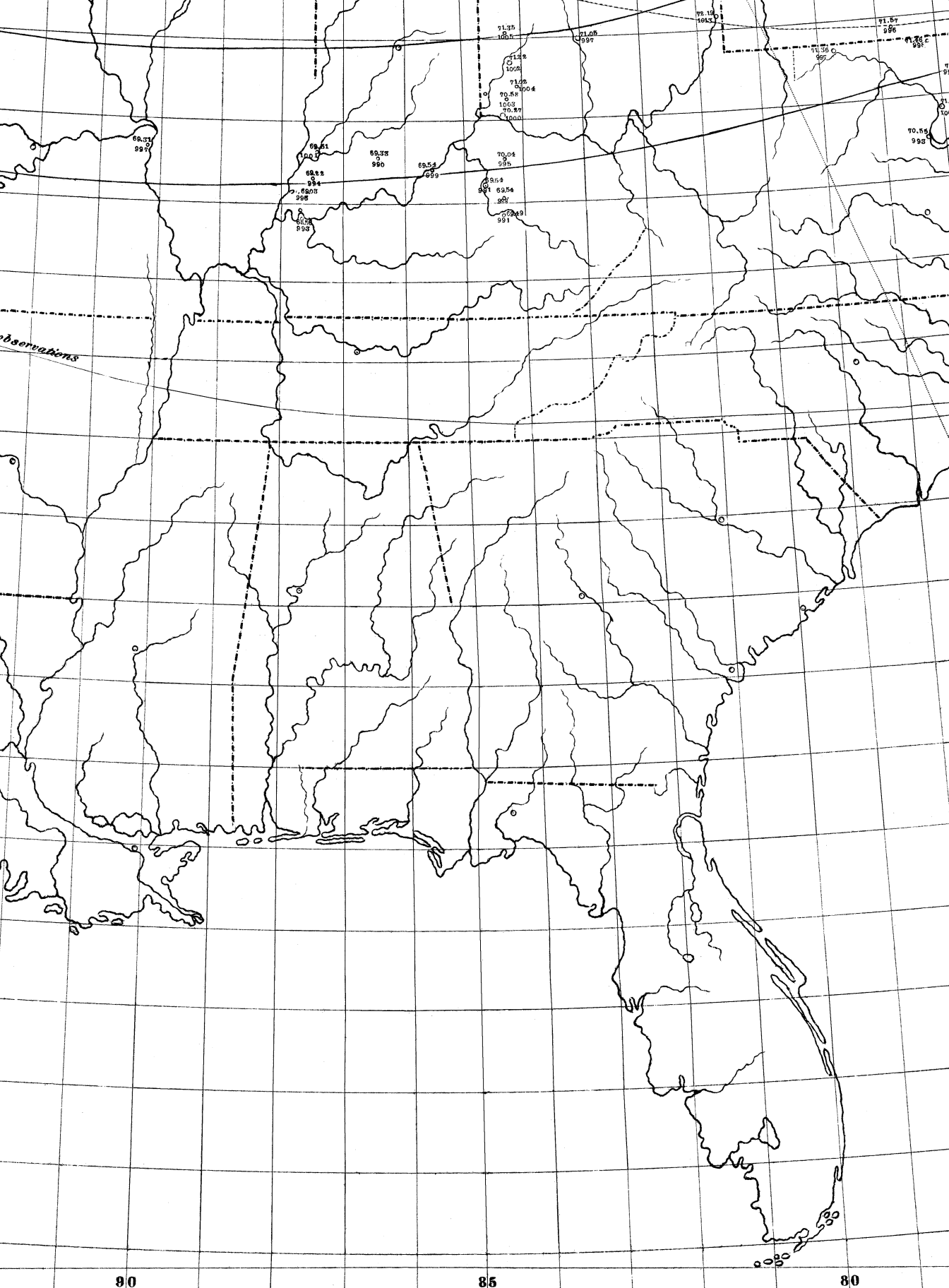
" 316, 317, and 318, in the heading of the ninth or last column of the tables, for "Total intensity, horizontal being 1000," read *Total intensity, that at Cincinnati being* 1000.

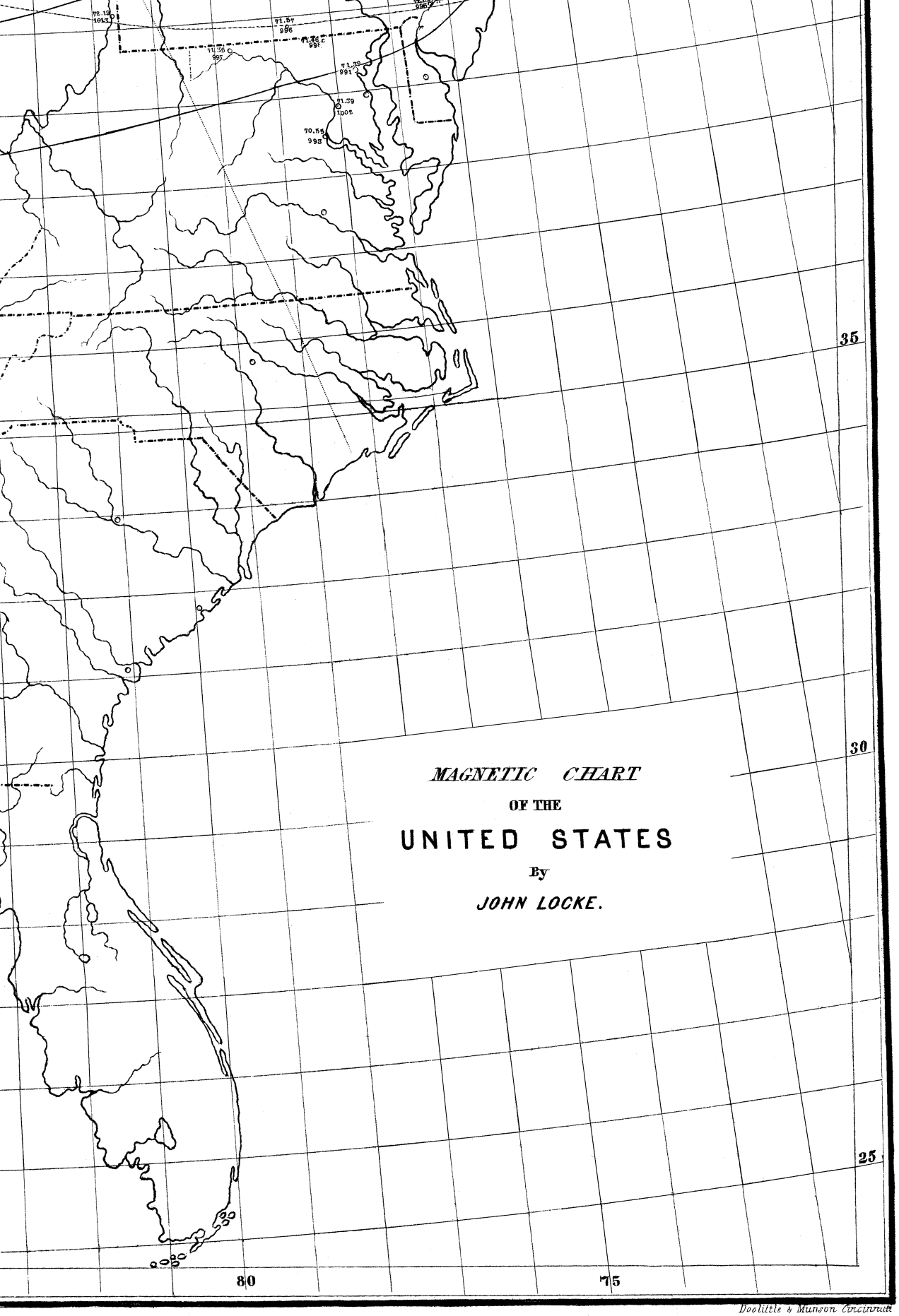

100
95
90
50
45
40
Axis of Greatest Magnetic Attraction
Sabine 1828.4. Locke 1060.
S. 18331. L. 1024.
Sabine 1828. Locke 1039.
S. 1836.6 L. 1024.
Isodynamic lines
S. 1828.7. L. 1018.
Isoclinal lines
S. 1820.5. L. 1004.
Sabine 1808.4. Locke 994.
Col. Sabine's line of 1700. Projected as an approximation from observations made on the extreme limits of the continent.


90
85
80
75
Axis of Greatest Magnetic Attraction & Subsidence
Locke 1060.
Line of no variation


80
75
70
50
40
35
Dip 72.00
75.19
1025
74.44
1007
74.38
1006
74.36
1013
74.49
990
74.46
998
74.06
984
73.57
996
73.30
988
73.25
1033
73.08
1016
73.00
1012
73.56
1005
73.21
984
73.35
1000
73.45
1004
73.19
1013
72.25
985
72.00
986
71.57
996
71.36
997
71.39
991
71.39
1002
70.55
998


Sabine 1808. & Locke 1824.
Col. Sabine's line of 1700. Projected as an approximation from observations made on the extreme limits of the continent.
35
30
25
95
90


bservations
90
85
80



MAGNETIC CHART

OF THE

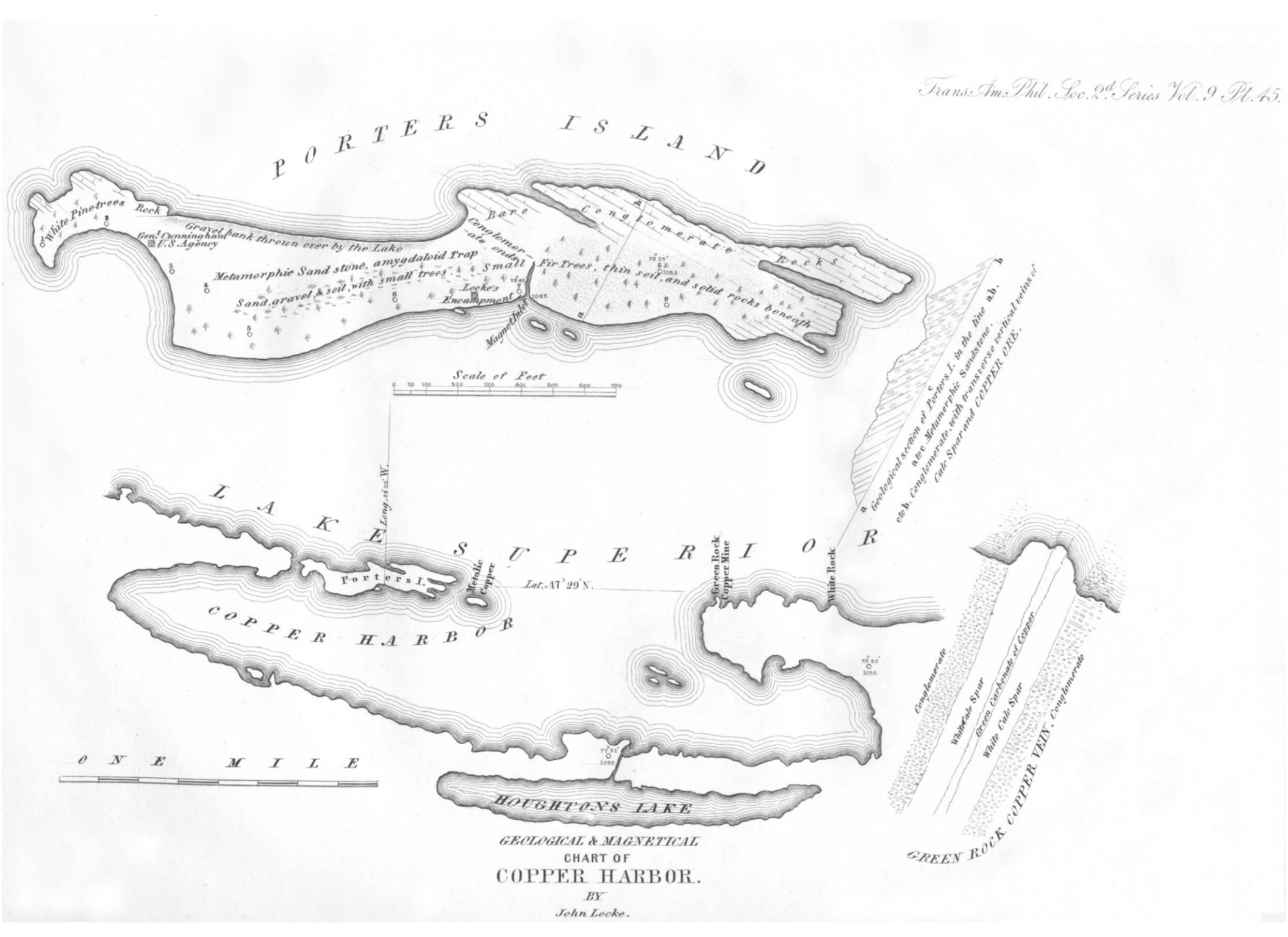
UNITED STATES

By

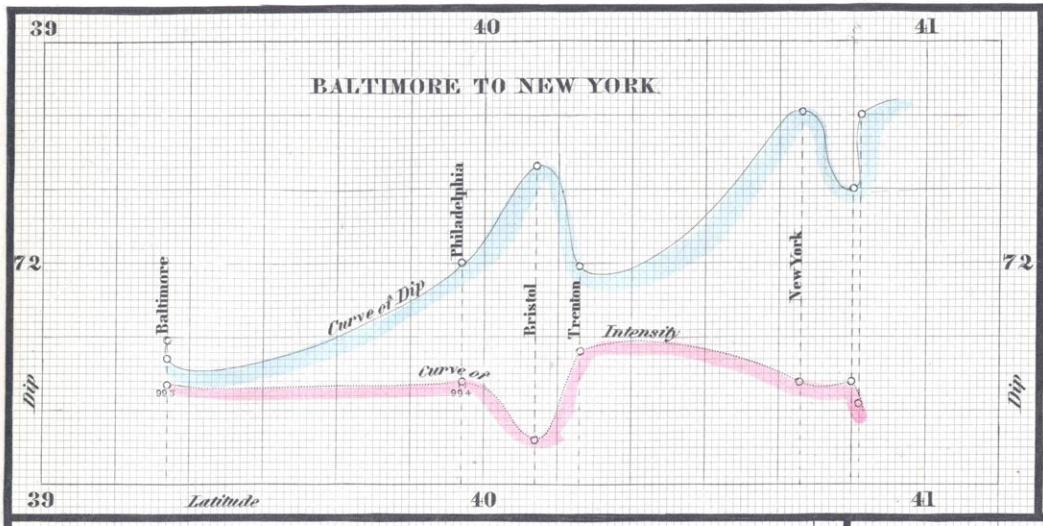
JOHN LOCKE.

Doolittle & Munson Cincinnati

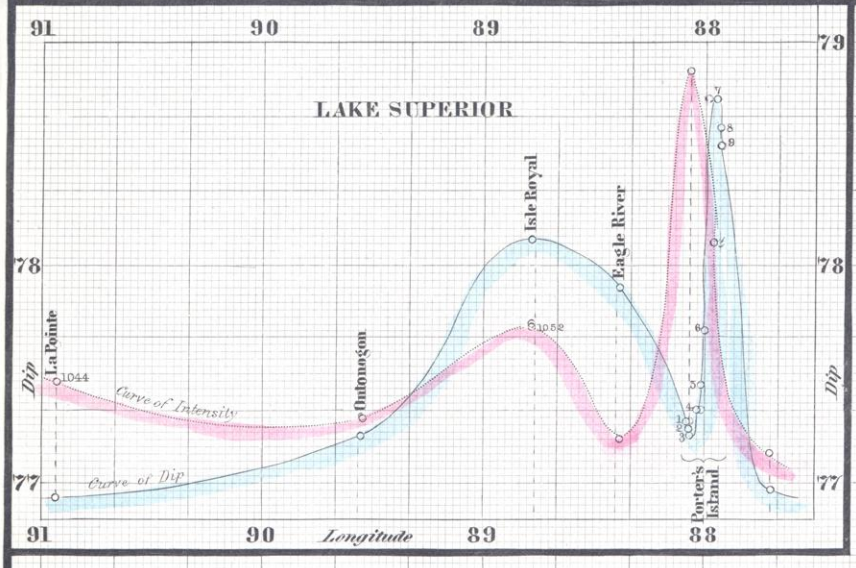
Trans: Am: Phil. Soc. 2d Series Vol. 9 Pl. 45.

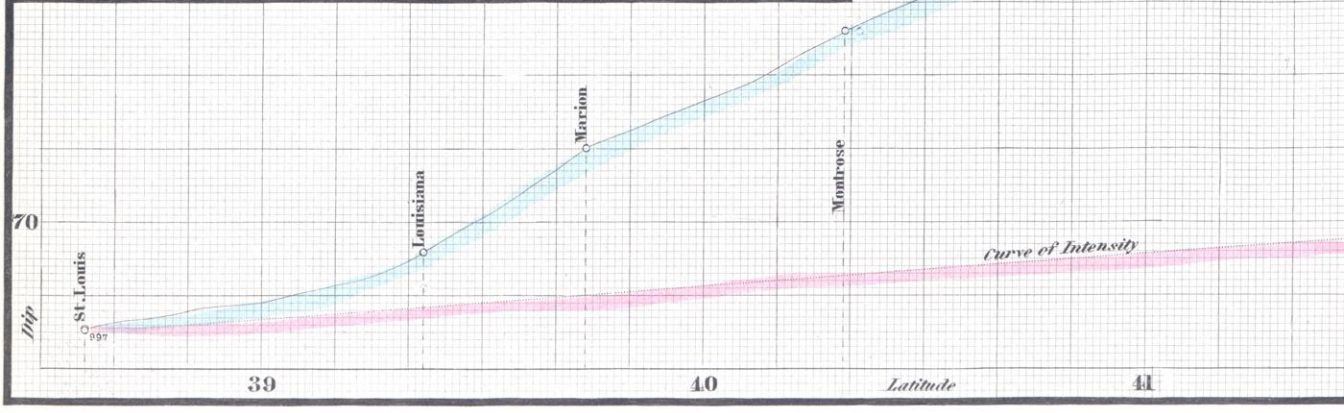


GEOLOGICAL & MAGNETICAL
CHART OF
COPPER HARBOR.
BY
John Locke.


BALTIMORE TO NEW YORK
39
40
41
72
Dip
Baltimore
Philadelphia
Bristol
Trenton
New York
Curve of Dip
Curve of
Intensity
993
954
39
Latitude
40
41

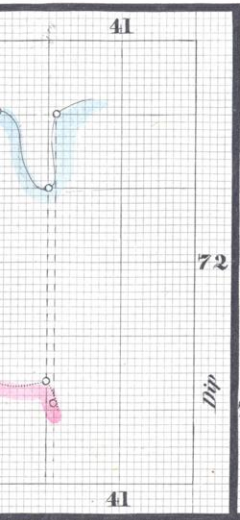

38
71
72
Dip
70
Clays Ferry
Lexington
38
Latitude

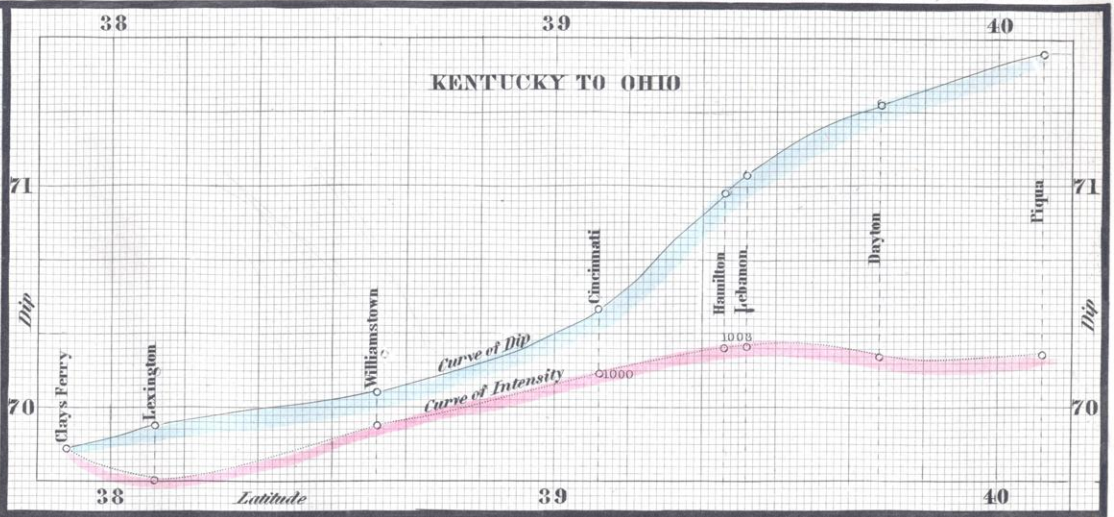

LAKE SUPERIOR
91
90
89
88
79
78
77
Dip
La Pointe
1044
Ontonogon
Isle Royal
Eagle River
1052
Porter's Island
Curve of Intensity
Curve of Dip
91
90
Longitude
89
88

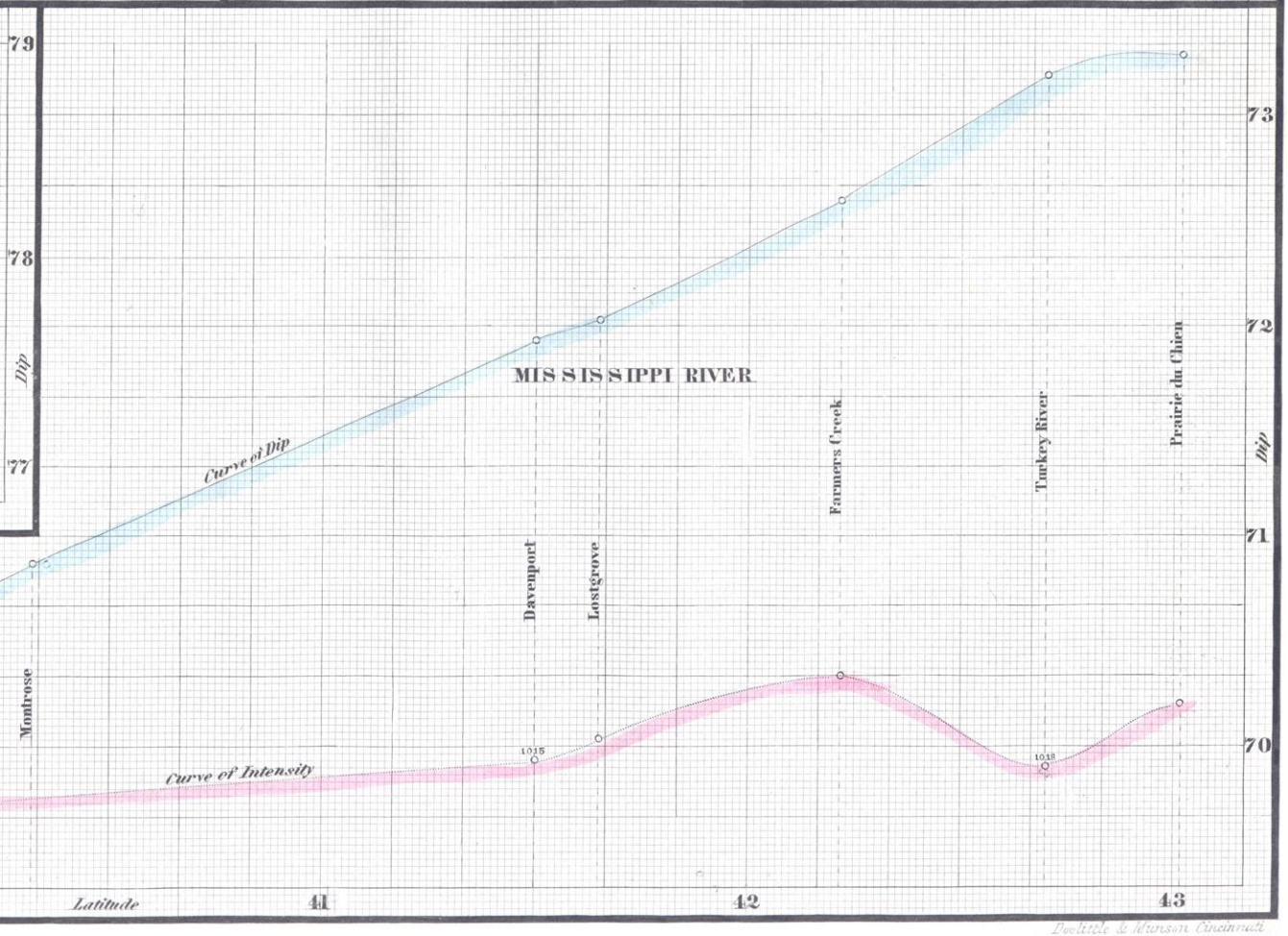

70
Dip
St. Louis
997
Louisiana
Marion
Montrose
Curve of Dip
Curve of Intensity
39
40
Latitude
41

ES showing the DIP & INTENSITY by means of ORDINATES.

Trans. Am. Phil. Soc. 2d Series Vol. 9 Pl. 46.







Doolittle & Munson Cincinnati